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ACADEMIC FREEDOM AND SECURITY PROBLEMS

SINCE 1948 a group of scholars, working under the general guidance of Dr. R. E. Cushman at Cornell University, with the assistance of a grant from the Rockefeller Foundation, has studied the impact upon civil liberties in the United States of current government policies designed to ensure internal security and to expose and control disloyal or subversive conduct. These studies, of which the first report, by Prof. W. Gellhorn, entitled "Security, Loyalty and Science", appeared in 1950 (see *Nature*, 168, 1051; 1951), have covered the work of the Federal and State "un-American activities" committees and the operation of loyalty and security programmes at all levels. Prof. Gellhorn's book and its successors, of which the latest is Miss Eleanor Bontecou's "The Federal Loyalty-Security Program"*, thus enable scientists and others to gain a clearer idea of what is happening and of the effects upon scientific work and academic life than would otherwise be easily possible. Moreover, they demonstrate that responsible leaders in the academic and scientific world in the United States fully recognize the dangers of the present situation, and are determined to resist abuses which threaten to undermine security as well as to destroy the conditions in which scientific work and all creative activity flourish.

Miss Bontecou's book attempts to present, primarily for the American citizen, the facts and reasoned judgments which should form the basis of a sound and informed public opinion. To some extent it has been rendered out of date by the concentration of the new Administration in Washington on security as offering more 'objective' standards, and Miss Bontecou points out that, by its terms of reference, her study could not be entirely objective. She was required by the conditions of her grant to make "a factual examination of the civil liberties issues which arise from acts taken to eliminate subversive individuals from government service". This objective determined both the approach and the emphasis of the study. Only in passing could she consider the effect of current practices on internal security or on the quality of the Civil Service in the United States.

Her book is thus of less direct interest to the scientist than Prof. Gellhorn's study; but it illuminates in a scholarly way the general issues which were considered in Mr. Alan Barth's "The Loyalty of Free Men". Moreover, to the British reader, a postscript, "The English Policy", based on a study of British loyalty-security policies and procedures during Miss Bontecou's visit to Great Britain in 1950, gives further interest, even though the findings of the postscript are presented primarily to throw further light on American practice for the benefit of the American reader. Although Miss Bontecou did not have access to any confidential material or the reports of the Federal Bureau of Investigation, she

* The Federal Loyalty-Security Program. By Eleanor Bontecou. (Cornell Studies in Civil Liberty.) Pp. xi+377. (Ithaca, New York: Cornell University Press; London: Oxford University Press, 1953.) 40s. net.

states that officials responsible for operating the loyalty and security programme in the United States co-operated generously with her so far as security regulations permitted. Indeed, her book is noteworthy both for giving a clear account of the genesis and operation of the programme, and for the way the issues are formulated in terms which command universal consent from those concerned with the defence of freedom of thought, investigation and communication.

Not merely Miss Bontecou's findings but also many of her observations are as pertinent to conditions elsewhere as in the United States. Her comments on the quality of the staff required for the execution of the loyalty and security programme deserve to be noted. She was impressed with the way in which, in spite of somewhat mechanical methods of selection, men of solid worth and human qualities, with a lively sense of their responsibilities and the possible impact of their activities on the lives of those who came before them, were secured to serve on the boards responsible for investigations in connexion with security regulations. Often they were men of wide experience, fine intelligence and sensitivity. She noted, however, that often a board member's understanding of the activities and motivation of the employee before him was limited.

But it is important, as Miss Bontecou rightly points out, that the loyalty boards should judge rightly as well as inspire confidence, and here the tendency to think that the lines between loyalty and security are sharply drawn and readily discernible is a stumbling-block. It is probably due to this that the actual protection afforded the employee, and incidentally the Government, by the judgments of the reviewing board, depends largely upon the agency in which the case arises. Equality of substantive standards is difficult to achieve in such a new field as loyalty judgments, and Miss Bontecou suggests that only reasoned case-by-case decisions can establish gradually the precedents which make this possible. Meanwhile, because the confidential character of loyalty proceedings essential for the protection of employees have not been observed, Miss Bontecou concludes that, for whatever reasons, the Loyalty Review Board no longer holds the scales in balance between the interests of the employee and of the Government: they are now definitely tipped against the employee. Nor is this all. Reviewing the conduct of the investigations of character and loyalty now required by the Loyalty Order, she points out that the impact of the inquiry and the activities of the many persons visited and invited to testify are quite beyond the control of the investigating agency. She observes bluntly that the quest for security by means of such wholesale investigations may demand a price too high for a free society to pay. Fear of the informant may stifle free discussion, bringing the preoccupation with conformity which Prof. A. Macbeath denounced so finely in his plea for 'heretics' at the Belfast meeting of the British Association.

Miss Bontecou quotes evidence enough to justify her contention that no one who is the subject of a loyalty case can view the present or future with any serenity or sense of security. Moreover, when Congressional attack is liable to follow loyalty investigations, no employee will readily support a view which runs counter to current popular opinion on a controversial issue. A premium is placed on conformity rather than initiative and courage, to the detriment of the Government service. The cost of such proceedings is not even limited to the very considerable expenditure of time, money and human happiness incurred in executing the loyalty programme. There is evidence that at the professional level recruitment has become more difficult, and Miss Bontecou's remarks on the indirect effects of the loyalty proceedings and the creeping paralysis of freedoms that follow support all that Prof. Macbeath urged at Belfast. Even from the point of view of national security, the erosion of freedom of thought and speech, and the destruction of individual dignity, are dangerous consequences. "Insidious encroachment by men of zeal, well-meaning but without understanding," threatens national security as well as freedom, and not in the United States alone.

One difficulty which is brought out by Miss Bontecou is the impediment to public criticism which arises from the refusal to make public the basis on which American organizations are listed by the Attorney General under the Loyalty Order. The difficulties of definition are fully recognized by her, but when the process is kept secret the corrective of public opinion cannot be applied intelligently. Furthermore, apart from the validity of any such list, this study shows the futility of attaching significance to membership of an organization proscribed on such a list in attempting to discover subversive individuals, while its impact on the right and practice of freedom of association is exactly what was foreseen by Tocqueville: "When some kinds of association are prohibited and others allowed, it is difficult to distinguish the former from the latter beforehand. In this state of doubt men abstain from it altogether and a sort of public opinion passes current that tends to cause any association whatsoever to be regarded as a bold and almost illicit enterprise".

There are reasons why such discouragement of the practice of association could have particularly untoward social consequences in the world of to-day. Nor will Miss Bontecou's hopes that the United States courts will refuse to be barred from consideration of the real issues by the label 'security' be encouraged by the Supreme Court upholding, with a majority of five to four, a verdict of the California court which allowed search and seizure, described by the dissentient minority as infringing civil rights guaranteed by Federal law and characteristic of the police or totalitarian State.

Both in the United States and in Great Britain, maintenance of our traditional freedoms and respect for fairness is as essential a part of national safety as the forging of weapons or the raising of armed forces. If public knowledge or public feelings make it impossible effectively to protect Government employees against false accusations, and especially

when it is necessary to protect Government service from subversive elements over a period of years, a whole generation can become so inured to the sacrifice of fundamental rights in the interests of real or imagined security that it ceases to place any great value upon those rights. Such attrition is probably the way in which rights and liberties are most likely to be destroyed throughout the free world; for direct assault is unlikely to succeed. The great value of such studies as those that have appeared in the Cornell Studies in Civil Liberty will be very evident. They show that some temporary sacrifice of fundamental freedoms may well be demanded by the tensions of the time; but they encourage the formation of an intelligent public opinion which will not accept such sacrifice with complacency. The maintenance of the fundamental freedoms is an essential element in the defence of a free society, and administrative convenience must not be confused with national security.

THE ROCKET AS A RESEARCH TOOL

High Altitude Rocket Research

By Homer E. Newell, Jr. Pp. xiv+298. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 7.50 dollars.

MEN have long been attracted by the possibility of being able to carry out explorations far above the earth's surface. In 1784 Vincent Lunardi made the first balloon ascent from London, his achievement arousing great popular enthusiasm. Attention, too, was directed to the advances in knowledge which might be gained. Judging from the various comments he made, it was, for example, this aspect which most interested Samuel Johnson, then in the last months of his life: he gloomily recorded that the new vehicles "can gratify no curiosity till we mount with them to greater heights than we can reach without, till we rise above the tops of the highest mountains, which we have yet not done".

When rather more than a century and a half later rockets began to fall on London they aroused different feelings; but men of science found some compensation in the recognition of the fact that a weapon of real use had been developed. During the early part of 1946, an important meeting was held in Washington, D.C., at which the exploitation of the German invention was discussed and a programme of fundamental research was formulated. Dr. H. E. Newell, head of the Rocket-Sonde Research Branch of the Naval Research Laboratory, now presents in this book a lucid account of the work done up to the end of 1952. The splendid success attained in this difficult field must be a source of intense satisfaction to those responsible for the initiation and execution of the project; and it raises the question as to whether similar research should not be commenced in other countries besides the United States.

The original *V2* rockets, of which about a hundred were captured, had an impressive performance, being able to carry a weight of 2,200 lb. to an altitude of 160 km. Nevertheless, they had some undesirable features such as instability after powered flight and inflexibility of pay-load. Other types of rocket, designed specifically for high-altitude sounding, were therefore produced. Of these the most notable are the 'Aerobee' and the 'Viking'. According to one of the numerous informative diagrams in Dr. Newell's book, the former can take 230 lb. to about 75 km. or 100 lb. to 120 km., and the latter can take 1,500 lb. to about 130 km. or 500 lb. to 220 km.

A rapidly moving rocket does not, of course, provide an ideal platform on which to mount measuring instruments; but in spite of this many results have been derived. Perhaps the most valuable are those relating to the density and the temperature of the upper atmosphere, those relating to the electric current system causing the diurnal variation in the magnetic field, and those relating to the solar emission in the spectral range which cannot be observed from ground-level. Other problems have, however, been attacked. For example, much effort has been devoted to certain facets of cosmic-ray research; again, experiments have been begun on the determination of the chemical composition of the air at various altitudes, and quantitative information on the ozone content up to the 70-km. level has already been obtained.

Avoiding excessive detail, Dr. Newell gives an admirable description of these widely different investigations. He summarizes the main results clearly and appends a useful bibliography to each chapter. Occasionally he indicates that he has doubts as to the validity of some of the inferences drawn. As an example of this, it may be mentioned that he is rather sceptical of the apparent evidence favouring the occurrence of appreciable diffusive separation of the atmospheric gases in the region between the 60 and 70 km. levels. His scepticism seems justified, for in a footnote added after the main text was written, he states that it has since transpired that the sampling technique used may have been at fault.

"High Altitude Rocket Research" will certainly become a standard reference book, and specialists should ensure that they have ready access to a copy. Moreover, the book is easy to understand and should appeal to the general scientific public. The production by the Academic Press, Inc., is excellent; but it is regrettable that the price should be rather high.

D. R. BATES

MODERN PHOTOMETRY

Photometry

By Dr. John W. T. Walsh. Second edition, revised. Pp. xxiv+544. (London: Constable and Co., Ltd., 1953.) 63*s*. net.

SINCE 1926 Dr. J. W. T. Walsh's "Photometry" has been the standard British text-book on the subject, and the appearance of a new edition is a major event to those concerned. There have naturally been many new developments during the past twenty or thirty years which needed to be put on record, in particular the wide application of photoelectric devices to light measurement, while the extension of photometry to scotopic conditions and to the subjective effects of light has required some elaboration to the basic photometric concepts.

The first edition of Dr. Walsh's book was outstanding both in content and presentation. It gave a comprehensive and exhaustive account of photo-

metric principles and practice, it had great clarity of style, the diagrams were very good and the references were virtually complete. The new edition, for which more than two-thirds of the book has been re-written, is perhaps not quite so comprehensive as the first in relation to the growth of the subject, and some techniques which are becoming out-dated probably occupy more space than is justified. Thus, in the chapter on heterochromatic photometry, the description of several different types of flicker photometer gives this method a prominence which it scarcely deserves at the present time. But in other respects the same high standard has been achieved, and the list of references at the end of each chapter is again something at which to marvel. Indeed, while only the key references prior to 1925 have been retained, the author has aimed at including a reference to every relevant paper published since that date.

One must sympathize with the author on the matter of terminology. The text was being re-written at a time when photometric and colorimetric terms were under active consideration by various national bodies, and internationally by the Commission Internationale de l'Eclairage. As a postscript to the preface reveals, the 1951 resolutions of the Commission were approved while the book was in the press; but in spite of this the nomenclature and definitions have been altered to bring them into accord with these, the most recent, international decisions. The author is to be thanked and congratulated on the effort which this late amendment must have involved.

To a good many people, photometry is probably remembered mainly as an adjustment of two lamps relative to a grease-spot or shadow photometer, and they might be surprised at the subtleties that are now involved. Light is a commodity on which a great deal of money is spent, and it is very necessary that valid methods of measurement should be employed to ensure that we get good value for our money. Yet the measurement is not a simple measurement of physical radiation and energy, for account has to be taken of the visual effect produced by the light. It can happen that two beams of light which look equally bright under one condition of viewing may not appear equal when the viewing conditions are changed. This may occur, for example, when lights of different colour are compared on different parts of the retina or when the conditions of visual adaptation are changed. Conventions have therefore to be established, and it is no easy matter to define them so that the results are in accord with what the customer sees. Indeed, even with the present conventions, it can happen that a fluorescent lamp having a given lumen output may appear less bright than another lamp of lower output, if the two lamps are of somewhat different colour.

Problems such as these help to keep photometry very much alive, and this activity is well reflected in Dr. Walsh's book, although his arguments may sometimes be open to criticism. Thus the discussion and diagram on p. 75 perhaps suggest a more rigid relation between subjective brightness and luminance than in fact exists, since the effect of adaptation is ignored. There seems to be some confusion here between equivalent luminance and subjective brightness, and while this may in part be merely a question of terminology, two separate concepts are involved which require to be distinguished. This is, however, a fine book which will be highly valued both in Great Britain and abroad.

W. D. Wright

DIMENSIONAL ANALYSIS

Physical Similarity and Dimensional Analysis
An Elementary Treatise. By Prof. W. J. Duncan. Pp. viii+156. (London: Edward Arnold and Co., 1953.) 30*s*. net.

DIMENSIONAL analysis is a powerful tool which is often regarded as a detached technique, a sub-mathematics for deriving utility results when matters are too complex for respectable analysis, or even as a kind of 'black market' way of obtaining formulæ which are in short supply. One of Prof. W. J. Duncan's aims in this admirable book is, as the title suggests, to explain how dimensional analysis is rooted in the theory of physical similarity, which itself is derived from that most orthodox of ancestors, the geometrical approach of Newton. He also shows, giving a wide selection of examples, the power and simplicity of the method, and warns the reader in forthright terms of its limitations.

Two of the earlier chapters explain the concept of similarity. Geometrical similarity implies the constancy of a non-dimensional parameter, simply a length ratio; kinematic similarity the constancy of the Froude number; and similarity of motion in a viscous fluid the constancy of the Reynolds number. In general, the conditions for similarity lead to relations between two or more dimensionless quantities of the same form as the relations derived using the Π-theorem, so that both approaches are basically equivalent.

The propagation of surface waves on a liquid is taken as an instructive example of the routine application of dimensional analysis to a simple problem, and it is shown how the form of the relation changes as changing conditions alter the relevance of some of the factors involved. The use of non-dimensional coefficients (such as the lift-, drag- and pitching-moment coefficients in aircraft calculations) is explained, as is the simplification of experiments by varying one whole coefficient at a time and observing its effect on the others, instead of laboriously varying single-component factors. Much depends on the selection of suitable non-dimensional combinations in the first place, and the author explains how the Π-theorem may be used to select fruitful, though not unique, combinations.

The application of dimensional analysis to heat-transfer problems, where it is invaluable, and to electromagnetism, where it seems a little artificial, occupies two chapters and illustrates the generalities of the method. There is a chapter on the use of non-dimensional coefficients in design, which deals with screw-propellers, pumps, turbines, and designing for aircraft performance. This is indeed not severely technical nor difficult for the non-specialist to follow, but explains the principles of the methods used very simply and clearly. So that the reader shall not lose sight of the principle of similarity itself, the author devotes a chapter to its use in solving two particular problems, the bending of a cantilever and the deflexion of a membrane, the latter leading to several interesting analogues. He emphasizes that this is indeed rigorous mathematics, though using pure geometry instead of the calculus.

The book can be welcomed as an excellent introduction to the subject, which offers the reader every help towards understanding dimensional analysis and its place in physics, and does everything possible to remove the confused ideas about the nature of equations and units which many people bring to the

subject at first. The author's use of the term "measure formula" for "dimensions", and his continual reminders that an equation must be true in any consistent units, are two of the many small but helpful devices which make for clarity; and he is careful to point out that the successful use of the process of analysis demands intelligence and a close study of the physics of the problem concerned. G. R. NOAKES

PROGRESS IN NUCLEAR PHYSICS

Progress in Nuclear Physics
Vol. 3. Edited by Prof. O. R. Frisch. (Progress Series.) Pp. vii+279+4 plates. (London: Pergamon Press, Ltd., 1953.) 63*s*. net.

THE third volume of "Progress in Nuclear Physics", edited by Prof. O. R. Frisch, and published annually, contains articles on subjects of current interest which will appeal to nuclear physicists in general. As in former volumes, both technical and theoretical advances are represented, and the topics chosen are treated at a level which strikes a useful mean between the fully detailed monograph and the shorter text-book account.

Four articles deal in part with instruments for the detection of nuclear particles. The diffusion cloud chamber, described by M. Snowden, has already shown its possibilities in detecting artificially produced V^0-particles and will be much used in the future. D. West describes the construction and application of the precision proportional counter, which has been used in studies of low-energy β-, X- and γ-radiations, and has important advantages in resolution over the scintillation counter. F. C. Champion contributes an account of the crystal conduction counter, in which he gives a reminder that the counting properties of diamond may throw light on the solid state, even if they find no great application in nuclear physics. Čerenkov radiation is treated in an exhaustive article by J. V. Jelley. Many will be interested in his account of the early experiments and in his exposition of the theory; the article goes on to describe the application of Čerenkov counters to cosmic-ray work and to the high-energy field in general.

Although improved methods of detection enable good use to be made of the relatively small beams available from high-energy accelerators, it is still important for these beams to be increased. The problems of providing an intense beam of ions for acceleration are ably discussed in an article by P. C. Thonemann, who was himself responsible for stimulating interest in the popular radio-frequency ion source.

The remaining articles are devoted primarily to exposition and interpretation of experimental results. R. J. Blin-Stoyle, M. A. Grace and H. Halban review the progress made in orientating nuclear systems and show what nuclear information can be obtained from observations of radiation patterns and polarizations. A remarkable contribution to an understanding of electromagnetic interactions has resulted from the discovery of positronium, the bound positron–electron system, by M. Deutsch; in an article in this volume, he reviews in a masterly way the whole subject of annihilation of positrons in matter. Nuclear dynamics is represented by contributions on deuteron stripping reactions and on the collisions of nucleons with deuterons. In the former article, R. Huby discusses the assumptions of stripping theory and gives numerous examples of the application of the theory to the determination of spins and parities of nuclear states. In the concluding article, H. S. W. Massey shows how measurements of total and differential cross-sections for the scattering of nucleons by deuterons can yield information on nuclear forces, including the force between two neutrons.

The articles in this volume are well balanced and informative. Some readers may complain of omissions; but these are inevitable in reports on rapidly expanding subjects. There are few textual errors, and the printing and production are excellent.

W. E. BURCHAM

CHEMISTRY AND TECHNOLOGY OF FOOD

The Chemistry and Technology of Food and Food Products
Second Completely Revised and Augmented Edition. Prepared by a Group of Specialists under the Editorship of Dr. Morris B. Jacobs. Vol. 1, pp. xxv+832; Vol. 2, pp. xxvi+833–1770; Vol. 3, pp. xxx+1771–2580. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1951.) Vol. 1, 12 dollars; Vols. 2 and 3, 15 dollars each.

THESE three volumes have been compiled by thirty-nine experts, many of them famous in their particular fields. In theory, a treatise such as this should be beyond criticism, but in practice it has obvious limitations: the expert is normally a very busy man; he usually postpones the writing of his contribution until a time limit has been set by the editor and then he rushes it through; he is restricted to so many words; and finally most experts are particularly resistant to criticism of what they have written. The editor of this work—now in its second edition—Dr. Morris Jacobs, has obviously come up against these difficulties. He writes in his preface, "In a collaborative effort, it is always difficult to avoid duplication"; and again, "Several contributors of the first edition were not able to revise their chapters on time".

To the British reader the book at first glance is almost exasperating in its completeness; nothing appears to have been overlooked. Half of Vol. 1 is devoted to fundamentals, including the chemistry of proteins, lipoids, carbohydrates, colouring matters, enzymes and vitamins; there are in addition two excellent chapters dealing with digestion and food spoilage. The rest of this volume deals with unit operations and processes (there is a subtle difference) and with sanitary control. Vol. 2 deals mainly with the history and chemistry of foods, and Vol. 3 with their production and preservation. The scheme as between Vols. 2 and 3 is not very clear, and in fact in Chapter 24, dealing with cereal grains, we are reminded by Prof. W. F. Geddes that this chapter is closely allied to Chapter 39 in Vol. 3. The dividing line between chemistry and technology is always a matter of opinion.

It is easy for a reviewer who has worked in one or more fields of food science to suggest defects or omissions in the sections covering work with which he is familiar. Since, however, none of us can claim authority in all the fields covered, this would scarcely be fair. There is, however, one omission which is

common to all the sections, and that is the tendency to overlook much of the work that has been carried out in Britain.

For whom is the book written? The preface does not tell us, but one thinks immediately of the relatively small group that includes the teachor of food technology, the food consultant, and the scientific (food) Civil servant. There are too many trimmings for the specialist, be he research worker, technologist or technician. Furthermore, the price is 42 dollars. Good as this work sets out to be—and it nearly succeeds—many will argue that the day of attempting to write a comprehensive text-book covering all foods has gone; we have advanced much too far for that. A discussion of the common factors in the technology of foods is much more likely to stimulate and make for progress. T. Moran

PLANT FORM AND FUNCTION

Plant Form and Function

By Prof. F. E. Fritsch and Sir Edward Salisbury. New and revised edition. Pp. viii+673. (London: G. Bell and Sons, Ltd., 1953.) 30*s*.

In their new edition of this well-known text-book the authors, while not making any major changes of plan, have made a thorough revision. In particular, they have widened the scope of the chapters on plant physiology, rewritten the chapters dealing with cell-division and heredity, and included new material on fossil plants and viruses. The text has in many places been brought up to date, and useful suggestions for further reading are given. The new material is clearly presented and a high standard of accuracy is maintained, although the illustrations are not always worthy of the text.

From some points of view, the new edition is an improvement on the old. For example, there is now a much fuller treatment of cytology and genetics. The relevant chapter contains a large amount of information in condensed form, though there are one or two mistakes, perhaps due to over-abbreviation (for example, in the account of *Primula kewensis*). But this method of adding a new chapter has its pitfalls. Thus fairly early in the book a long account is given of pollination mechanisms which favour out-breeding; but the evolutionary significance of out-breeding is dealt with in the later chapter on heredity, is not emphasized, and is not brought into relation with the information given earlier.

Perhaps the main criticism of the book is that it is not easy to read and, indeed, is often rather dull; and one cannot help feeling that, with comparatively slight rearrangement, it would be possible to convey all the information that is desirable in a more attractive way. This could be done by the more frequent introduction of topics of a general nature, around which the detailed discussions could be built, or from which they could develop. For example, the subject of classification could be introduced by describing the differences between natural and artificial classifications; and more use could be made of the numerous groups which are described in such detail to explain fully the concepts of order, family and genus. Another instance is provided by the chapter on fruits and seeds, which could be made much more interesting, and no less informative, by building it around the concept of reproductive capacity, a subject on which Sir Edward Salisbury himself has written a most fascinating book. Again, in the chapter on evolution and heredity, practically nothing is said about the origin of cultivated plants; this is a subject of general interest, about which a great deal is now known, and which could well be used for bringing the discussion of evolution to life, and to illustrate by reference to familiar plants such topics as variation, selection and polyploidy.

One may conclude by saying that this new edition of "Plant Form and Function" is remarkably comprehensive and reliable, and that it will continue to give valuable service to students. But if it were more a book to read, and less a work of reference, it would not be merely valuable; it would be indispensable. D. H. Valentine

FLOWERING-PLANT TAXONOMY: OLD AND NEW

New Concepts in Flowering-Plant Taxonomy

By Dr. J. Heslop-Harrison. (The Scholarship Series in Biology.) Pp. viii+135. (London: William Heinemann, Ltd., 1953.) 6*s*.

All botanists interested in the progress of their subject will feel indebted to Dr. Heslop-Harrison for this excellent and concise account of a rapidly expanding part of it.

While primarily concerned, of course, with the aims and methods of the new taxonomy, the author makes it quite clear that this development does not mean that the old taxonomy is now valueless. The traditional kind of classification is all-embracing and consequently provides a means of arranging in a convenient fashion most sorts of information about plants. It is perhaps least satisfactory when applied to the facts (as opposed to theories) of phylogeny, and it is here that the 'experimental' classification is of particular value, though it cannot replace but only supplement the well-established hierarchy of species, genus, etc.

After a lucid account of the development of taxonomy, Dr. Heslop-Harrison devotes the bulk of his book to a consideration of the kinds of variability, and the importance of the understanding of breeding systems and cytology, the whole illustrated by concrete examples drawn from a wide range of flowering plants. The emphasis throughout is on the study of living natural populations, or at least reasonable samples of such populations, rather than arbitrarily selected and generally dead individuals. In fact, it is made clear that this recent development of taxonomy is the practical, experimental study of evolution, which yields as a by-product facts of importance in classification, usually at the species level.

If one might venture on a minor criticism of a very valuable book, I would suggest that the necessity of the experimentalist identifying his material as accurately as possible in terms of classical taxonomy, and preserving herbarium specimens of it, should have been strongly emphasized. So much cytological work, particularly in 'critical' groups, is deprived of much of its value to the taxonomist because of uncertainty of identifications that this point cannot be too often stressed.

The publishers are to be congratulated on the pleasing appearance and remarkably low price of the book which, together with its admirable subject-matter, should ensure a place for it on the shelves of every student of botany. T. G. Tutin

Logarithmetica Britannica

Being a Standard Table of Logarithms to Twenty Decimal Places. By Dr. Alexander John Thompson. Part 2: Numbers 20,000 to 30,000, together with General Introduction. Issued by the Department of Statistics, University College, London, to commemorate the Tercentenary of Henry Briggs' publication of the *Arithmetica Logarithmica*, 1624. (Tracts for Computers, No. 22.) Pp. v+100+cvi. (London: Cambridge University Press, 1952.) 45*s*. net.

TO commemorate the tercentenary of Henry Briggs's publication of the first great table of common logarithms, the "Arithmetica Logarithmica", in 1624, the author of this work undertook the monumental task of producing a table of the logarithms of all numbers from 10,000 to 100,000, to twenty decimal places.

The whole table is divided into nine main parts, each containing the logarithms of ten thousand numbers, but the chronological order of publication does not correspond with the numerical order of the number-groups involved. Part 9 (90,000–100,000) appeared first in 1924, to be followed at irregular intervals by Parts 8, 4, 5, 6, 1, 7 and 3, this last in 1937. This final part (Part 2) was almost ready by 1939, but the outbreak of the Second World War caused a severe delay, and not until as recently as 1952 did it eventually materialize. Now that the whole work has been completed, the author feels that most users will, on account of its thickness, wish to bind it in two separate volumes. He has therefore included two title-pages, one for Parts 1–4, and the other for the remainder. As already stated, the main entries are to twenty decimals, but in addition there are second differences to eleven, and fourth differences to three, significant figures.

The introduction to the completed work is also supplied in this part and is very comprehensive, running, as it does, to some hundred pages. Among its contents are to be found a valuable memoir of Briggs and his work, not to mention a list of the errors in the ranges 1–20,000 and 90,000–100,000 of the original of three hundred and thirty years ago.

J. H. PEARCE

Crime Investigation

Physical Evidence and the Police Laboratory. By Prof. Paul L. Kirk. Pp. xxii+784. (New York and London: Interscience Publishers, Inc., 1953.) 10 dollars.

THE increasing use of scientific methods in crime detection and the encouragement to use the laboratory extended to the C.I.D. and F.B.I. detective officer during training have revealed a serious shortage of specialized technical staff. The gap has been filled in many parts of the world by using the services of chemists for toxicology, of biologists for serology and of physicists for ballistics, adapting their skill in volumetric analysis, absorption methods or spectrography respectively to the needs of the law.

Prof. Paul Kirk, the Californian biochemist, has shown such ability in this direction as to have added to his chair in biochemistry the complementary subject of 'criminalistics', and a perusal of his comprehensive new book on the application of the basic sciences to crime investigation reflects his sound and practical interest in police problems. It comprises sections on the "Approach to the Scene", set at police-officer level, the "Observation and Recording of Physical Data" (set at a higher technical level for the crime-detection team), and "Complementary Laboratory Techniques" designed to help the occasional medico-legal man of science to discharge his responsibilities with reasonable security. In physical fields (comparison techniques as for tool-marks, hairs, fibres, soil, glass, etc.) and in biochemical and toxicological analyses, Prof. Kirk is plainly authoritative. He writes less informatively on ballistics, fingerprints, arson and forensic serology because one just cannot acquire special skill in everything in such a vast field.

The book is lavishly and well illustrated, providing an excellent guide to the general science worker who may suddenly be called upon to handle a branch of science with which he is unfamiliar, to the teacher of the detective officer and, no doubt, to Crown counsel or the district attorney who desire information on this rapidly growing subject for court purposes. It is produced to American standards—and priced accordingly.

KEITH SIMPSON

Astrology and Alchemy

Two Fossil Sciences. By Mark Graubard. Pp. xi+382. (New York: Philosophical Library, 1953.) 5 dollars.

THIS work is a compilation and makes no pretence to scholarship. The author quotes standard works and a few original texts, but seems to have confined himself almost entirely to those that have appeared in English. Thus he seems to be unacquainted with the work of Festugière, who has so enlightened the problem of the relationship of alchemy, astrology and magic. The section on astrology and ancient astronomy, though inaccurate in detail, affords a reasonably good introduction to the subject. The author's knowledge of alchemical literature seems to go little beyond the translations of A. E. Waite: the author is clearly no chemist and this part of the book could have been omitted with advantage. There are a good many mistakes —helical for heliacal; Calippus and Callipus, on successive pages, for Callippus; Isagogue for Isagoge, zanthosis for xanthosis, etc. Molière is made to talk of morphine: there is mention of mercury trichloride. This kind of thing shakes belief in the author's competence. Add to this that the style is flat and that the work is interspersed with *obiter dicta* about Hollywood, Marxism, television, psychoanalysis and so forth, and it will be apparent that it will make little appeal to readers of *Nature*. Nevertheless, anyone who studied the book would end up with a very fair idea of ancient astrology and astronomy, and at least the earliest periods of alchemy. There are some good diagrams illustrating ancient astronomy. There is no bibliography, but references are given in parentheses.

Tensor Calculus

By Dr. Barry Spain. (University Mathematical Texts.) Pp. viii+125. (Edinburgh and London: Oliver and Boyd, Ltd.; New York: Interscience Publishers, Inc., 1953.) 8*s*. 6*d*. net.

THIS little book provides a concise account of the theory of tensors. In the first five chapters, dealing respectively with tensor algebra, the line element, covariant differentiation, geodesics and parallelism, and the curvature tensor, the fundamental concepts are introduced and developed "without undue stress on rigour", assuming little more than an elementary knowledge of determinants and calculus. The sixth chapter, the longest, shows how tensors can be

applied to Euclidean three-dimensional differential geometry. It is not intended to give a complete course on this subject, but to indicate to beginners the scope and power of the method. The seventh chapter starts with Cartesian tensors, then gives an excellent short note on Klein's famous "Erlangen Programm", and concludes with a sketch of the theory of elasticity, treated from first principles by tensor methods. The eighth and last chapter gives a brief but intelligible account of the theory of relativity, including Einstein's general theory and De Sitter's cosmological theory. Every chapter contains some examples for solution, and the book concludes with a bibliography and index. The beginner could scarcely find a better account of the subject.

One small criticism may be made. In the historical introduction (p. 1), it is not mentioned that the word tensor has completely changed its meaning. The original definition (due to Sir William Hamilton in his work on quaternions), which became obsolete about 1916, due to Einstein's use of the word in the modern sense, is nevertheless still given in the Oxford English Dictionary and in a most modern medium-sized dictionary, published in 1952.

H. T. H. Piaggio

Birds of Mexico

A Guide for Field Identification. By Emmet Reid Blake. Pp. xxx+644. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 45*s*. net.

With the increase of air travel, Mexico is within easy reach of the United States, and this small handbook is prepared for bird-lovers in the latter country who are able to spend a holiday in Mexico.

The climate and topography of Mexico vary a good deal. On the Caribbean coast-line the country is open and humid, whereas on the Pacific slope it is arid. In the interior there is a high plateau with a temperate climate, and elsewhere there is tropical jungle of varying types. The avifauna is exceptionally rich, and nearly a thousand different species have been recorded within the area. This total includes many birds which breed in the United States and either winter in Mexico or pass through on their way farther south, and the remainder are peculiar to the country or are tropical species which extend into Mexico from Central America. There are a key to the species of each family and a short description of each bird, giving the general coloration as likely to be seen through a pair of field-glasses. In addition, there are about three hundred and twenty line-drawings which should be of great assistance to the observer. Owing to the necessity of keeping the book small, the field-notes are reduced to a minimum.

The Science of Society

An Introduction to Sociology. By Jay Rumney and Joseph Maier. Second edition. (Social Science Studies.) Pp. 208. (London: Gerald Duckworth and Co., Ltd., 1953.) 9*s*. net.

Although it is stated in the foreword to this book that the original edition published in 1938 "has been carefully re-edited and checked", it is nevertheless most valuable as a statement of the outlook of sociologists before the Second World War. Spencer, Durkheim and Max Weber are given adequate attention, but relatively little is said about the immense advances that have been made during and since the War. Moreover, the impact of the War itself on the social sciences is ignored altogether.

This is seen most clearly when the bibliography, which is stated to be "up-to-date", is examined in detail. Almost exactly half the entries in the sections relating to the scope and methods of sociology are of books published before 1939. Some might think this to be a fair balance, but this is obviously untrue of the sections dealing with more specific topics. For example, only a single post-war book is listed under the heading "Groups, Institutions, and Cultures", a branch of the subject in which changes in concepts and methods have been of a revolutionary order. To say the least of it, the work of revision has been very uneven.

As a really good elementary text-book of sociology still does not exist in this field, however, we must be content with something which is by no means wholly up to date until one is written. It is therefore a great pity that the authors could not have spared more time for the production of the new edition, as there is every sign in the present work that they could have satisfied our needs if they had done so. Their brief treatment of such fundamental issues as the quality–quantity dilemma, the pitfalls of the interview, and their underlining of the value of empirical studies are all evidence of sound judgment and critical ability of a constructive kind. T. S. Simey

Thermodynamics and Statistical Mechanics

By Prof. William P. Allis and Prof. Melvin A. Herlin. (International Series in Pure and Applied Physics.) Pp. viii+239. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 51*s*.

This book, which is divided into two parts, has been written for seniors in physics at the Massachusetts Institute of Technology, the object being to cover a half-year course in heat and thermodynamics and statistical mechanics. Part *A* commences with a review of mathematics, and then proceeds to a consideration of the empirical equations of state for pure substances, after which the laws for ideal and real gases are treated. The remainder of the section is concerned with the three laws of thermodynamics. Part *B*, on statistical mechanics, is to a large extent complementary to the first part and deals first of all with the relationship between entropy and the number of equally probable micro-states of a system. Then follow some of the well-known and fundamental applications of classical statistics, and finally the transition to quantum statistics is made; the last chapter of all considers the Bose–Einstein and the Fermi–Dirac distributions. There is an excellent selection of problems at the end of each chapter in the book; but, apart from one or two recommendations for further reading, there are no references to the literature.

The treatment of heat and thermodynamics is neat and concise, but, of necessity, some topics which are normally included in the subject have been eliminated; consequently, although the standard is appropriate, the pass-degree student will find that the section in itself is not ideal for his needs. Students at honours-degree level, with no previous knowledge of statistical mechanics and with only average mathematical attainment, should not experience any difficulty in understanding the principles introduced in the second part of the book. Part *B* does, in fact, serve as an admirable introduction to statistical mechanics.

THE BICENTENARY OF COLUMBIA UNIVERSITY

By Prof. L. C. DUNN

Professor of Zoology, Columbia University

THROUGHOUT the year 1954 there is being celebrated both in New York and at other centres of learning the two hundredth anniversary of the founding of Columbia University. The theme of the extensive series of symposia, conferences, lectures, exhibits and meetings of learned and civic societies is "Man's Right to Knowledge and the Free Use thereof", intended to illustrate not only the growth of knowledge but also its employment in the maintenance of free popular institutions.

Columbia University itself is an example of such an institution. King George II granted its charter as King's College in October 1754. It later became Columbia College, and at the turn of the twentieth century, at the time when, by union of the boroughs, New York City assumed its present metropolitan structure, the College and its affiliated schools assumed the style "Columbia University in the City of New York", emphasizing what has remained true from the beginning, namely, the intimate connexion between the self-supporting and independent university and the civic centre.

The aims of the College were set forth by its first president, the American scholar, Dr. Samuel Johnson (no kin to the lexicographer), in an advertisement published in New York, May 31, 1754: ". . . to instruct and perfect the Youth in the learned Languages, and in the Arts of reasoning exactly, of writing correctly, and speaking eloquently; and in the Arts of numbering and measuring; of Surveying and Navigation, of Geography and History, of Husbandry, Commerce, and Government, and in the Knowledge of all Nature in the Heavens above us, and in the Air, Water and Earth around us, and the various kinds of Meteors, Stones, Mines and Minerals, Plants, and Animals, and of every Thing useful for the Comfort, the Convenience and Elegance of Life, in the Chief Manufactures relating to any of these Things: And, finally, to lead them from the Study of Nature to the Knowledge of themselves, and of the God of Nature, and their Duty to Him, themselves, and one another, and every Thing that can contribute to their true Happiness, both here and hereafter . . .".

This statement makes it evident in what measure the College is derived from the same heady stream of confident benevolence which produced the Declarations of Independence and of the Rights of Man, and the American Constitution. Its large endeavour began in a very small way, in one room and with eight students; but soon it had a building of its own (near what is now Wall Street); a medical faculty was added in 1767, and gradually and slowly during its first century, other fields of learning. As it grew it moved progressively northward on Manhattan Island. In mid-nineteenth century it was in rural surroundings at 49th Street. Its botanical and pharmaceutical garden near by eventually furnished more than herbs, for on that spot now stand the skyscrapers of Rockefeller Center, and from the ground-rent of the garden the University derives a substantial part of its income. In 1897 the present University Center at Morningside Heights in upper Manhattan (114th to 120th Street) began to be occupied, and in 1928 there was erected the great aggregation of hospitals and laboratories, the Columbia Medical Center at 168th Street, in the centre of which is the Faculty of Medicine, which keeps its traditional name, the College of Physicians and Surgeons.

The most recent changes in the University were occasioned by the Second World War, when it became for a time the centre of research which led to the development of the atom bomb, and was the home of the Midshipmen's School from which 21,150 naval officers received their commissions during 1942–45. The expansion in staff and plant occasioned by these activities has now receded, leaving as permanent addition only the great cyclotron at Nevis, the University estate on the Hudson north of the city.

The form and extent of the University to-day—a federation of some twenty faculties and schools—are largely due to Dr. Nicholas Murray Butler, who was its president from 1902 until 1945. This vigorous philosopher, educator and public man gave twentieth-century actuality to the grandiose hopes of the enlightenment, by bringing together the men and women, who composed what he referred to as a Community of Scholars, the facilities, in the form of libraries, laboratories, and collections, and third, the material support which was needed. This forceful and, as some thought, domineering man found a way of leaving these ingredients free to make their own adjustments by which productive scholarship could be achieved in the midst of a busy modern city.

The diverse assembly of activities which appeared first at Columbia as part of a university enterprise were referred to by one of his more conservative contemporaries as "Dr. Butler's department store"; but, in fact, these innovations had begun before Butler's time. The School of Mines (first of its kind), which became the School of Engineering, dates from 1864; the School of Social Work, now a faculty of the University, celebrated its first half-century in 1948; the School of Library Service was founded during the 1880's by Melvil Dewey, father of the Dewey Decimal Classification, and immediately received women students—another shocking innovation. The non-professional graduate faculties of political science, philosophy and pure science, devoted to research and preparation of students for the doctor's degree, appeared in the 1880's and 1890's; while the usual activities of a university in arts, law and medicine had been present almost from the beginning. Teachers College, as a professional faculty of education, has been the centre of controversy since its first incorporation within the University under Dr. Butler, especially as there grew up within it workshops based on such radical ideas as those of John Dewey (progressive education). Those faculties which have a more modern sound—business, journalism, general studies (for adults)—now seem normal components with architecture, international affairs, dramatic arts, painting and sculpture, pharmacy and the others.

Dr. Butler's idea was that of a popular university where instruction of all kinds should be available to all who were prepared to receive it, always of course upon payment of a proper fee, since the University had no income from State, city or nation, and its endowment was never great enough to pay more than a part of the costs of instruction and research. Viewed from the outside, it did indeed appear a peculiar patchwork of different intellectual intensities —and Abraham Flexner, in "Universities, American, English, German", pointed out with telling sarcasm some of the contradictions and absurdities which developed within it. This never seemed to trouble Dr. Butler, probably because of his confidence in the attachment of the scholars at the heart of the enterprise to the controlling purpose of the University, that is, the advancement of knowledge and the training of students for independent intellectual activities and practice in the learned professions. Thousands of such students each year thronged its crowded corridors (some 25,000 per year), nearly all for graduate or professional training, for the original College foundation was restricted to a relatively small and select group of young men, now numbering about 2,200. The undergraduate college for women, Barnard College, now in its seventy-fifth year, is also small—about eleven hundred. Most of the university students come from other American colleges, and there are always more from other countries (1,600 this year) than in any other American university.

The history of Columbia does indeed show that sound learning based on research under conditions of freedom (that have in general been well maintained) can live and grow within the same environment which fosters popular teaching and applied work of all sorts of science, engineering, industry, education, and public service.

The scientific facilities of the University have always been modest, yet much useful work has issued from it. A typical figure from earlier days was Samuel Latham Mitchill, professor 1790–1801, physician, chemist, anthropologist, geologist and politician, of whose many contributions those are best remembered which engendered the violent controversy that led to the science of sanitary chemistry or engineering. In 1797 he established the first medical journal in the United States and edited it for twenty-three years. In the same tradition was James Renwick, professor of natural and experimental philosophy and chemistry, 1820–53, who wrote much on chemistry and geology but was chiefly distinguished as an engineer, an authority on railroads and canals. His inclined-plane canal lift is still in use on some British and French canals. Later came Charles Frederick Chandler, professor and dean, 1864–1910, a pioneer in public health; Michael Pupin, who began his productive and inventive work soon after he had graduated in 1883, inventor of the Pupin coil which made long-distance telephony possible, discoverer of secondary X-ray radiation; Leo Baekeland, responsible for 'Velox' photographic paper and for 'Bakelite'. For more recent work Nobel prizes were awarded to H. C. Urey, professor of chemistry (1928–45), for his discovery of deuterium; to I. I. Rabi, professor of physics, for research in the resonance method of registering the magnetic moments of atomic particles; to Enrico Fermi, professor of physics (1939–45), for work in atomic physics; to Hideki Yukawa, professor of physics 1949–54, for his earlier work on development of the meson theory.

One biological field which was given its modern form at Columbia is genetics. T. H. Morgan, professor of experimental zoology (1904–28, Nobel Prize 1933), together with his 'team' (A. H. Sturtevant, H. J. Muller, who received the Nobel Prize in 1946, C. B. Bridges and others) in a brilliant series of experimental analyses of heredity in *Drosophila*, carried out chiefly between 1910 and 1920, proved the chromosome theory of heredity and laid the basis of the modern theory of the gene. An important part of the foundation for this work was laid by Morgan's colleague in the Department of Zoology, Prof. E. B. Wilson, whose own classical investigations in cytology found lasting influence in his book, "The Cell in Development and Heredity", first issued in 1896, and now (in its third and final edition of 1928) recognized as one of the seminal books of modern biology.

Among other Columbia names in biology and medical research have been Selig Hecht, the physiologist, distinguished for his analysis of the visual process; Rudolf Schoenheimer, the biological chemist, whose book "The Dynamic State of the Body Constituents", itself marking a turning-point in the study of metabolism, showed how close he was, at his early death in 1941, by virtue of ideas gained from the use of isotopes, to new insight into the structure and reproduction of living matter; Hans Zinsser, bacteriologist (typhus fever) and writer; and many eminent men now living, and hence not mentioned here.

A unique chapter in scientific history at Columbia opened in 1939 and is described in the following excerpt from the report of the acting president, Frank D. Fackenthal, for 1945: "As is now well known, the atom bomb was the logical result of a discovery by Otto Hahn and F. Strassman of Berlin that some chemical elements of about half the atomic weight of uranium were present after exposing to neutrons specimens of pure uranium compounds which were previously free from any of these lighter elements. From this, Hahn, in an article published early in January 1939, reasoned that the nuclei of some of the uranium atoms had suffered splitting or 'fission' on picking up neutrons. Neils Bohr, of Copenhagen, arriving at Princeton, January 16, 1939, brought the news of Hahn's discovery and also the suggestion of Lisa Meitner and O. R. Frisch that the fission of an atom of uranium must be a very violent action liberating a large amount of energy. Prof. Rabi and Dr. Lamb, of our Department of Physics, brought the word from Bohr to Columbia, where it was seen at once that neutrons must be thrown off in the fission of a uranium atom, that these neutrons would cause other atoms of uranium to split and that thus a chain reaction could proceed with great rapidity and an enormous release of energy. In a few hours Prof. Fermi was estimating how large a part of Manhattan Island could be blown up by a few pounds of uranium properly disposed. As a result of discussions among Profs. Fermi, Dunning, Rabi, Pegram, Urey and others of our staff, experimental demonstration of the large amount of energy liberated by the fission of an atom of uranium was sought. In the experiment planned by Dunning and Fermi and carried out by Dunning on January 25, 1939, unmistakable evidence of the violence of the fission was found, the evidence appearing as relatively enormous pulses of ionization. Later it was learned that Frisch in Copenhagen had made the same demonstration ten days earlier. From that time

until now, the larger part of the work of Columbia's physicists and of numerous members of other departments has been devoted to the problems of nuclear fission and the release of atomic energy".

The "Manhattan Project", so-called, was centred at Columbia during 1939–45, utilizing much of the scientific space of the University and, with its scientific staff of 250 and 1,200 others, overflowing into other buildings in the neighbourhood. The work with the uranium–graphite pile was shifted to Chicago in 1942, and the chief effort at Columbia was devoted to the gaseous diffusion method of separating uranium-235.

The chief contributions of Columbia University, however, have been in fields other than science, which was a relatively late development. Great lawyers, judges, and legal scholars have issued in continuous line throughout its history—the two Roosevelt presidents coming from its law school, as also three chief justices and many associate justices; statesmen—from Alexander Hamilton, John Jay, DeWitt Clinton (the governor of New York who built the Erie Canal)—to the present governor. It was from Columbia that F. D. Roosevelt drew his 'brain trust' of 1932; his rival for the Democratic nomination in that year is said to have poached on Roosevelt's preserves, and the two candidates gave forth with one speech written impartially for both by the same Columbia 'ghost'. The Faculty of Political Science has had a long and honourable history, but it must be told by one who knows. In philosophy one thinks of John Dewey, who spent fifty active, even turbulent, years at the University; in anthropology, of Franz Boas, who between 1893 and 1940 was responsible not only for the creation of a school of linguistics but also put his stamp on the whole of American anthropology, both social and physical.

But it would be idle for one who is not a historian, nor capable of judgment outside of the restricted field of his own experience in science, to choose more persons or events for emphasis from an array extending over two hundred years.

I write from Rome, a distance of half the globe away, and after nearly a year's absence from that University. In the United States it seems like a European university, in the independence of its faculties and schools and departments, its avoidance of prescription or undue interference with the lives of its students and professors, the absence of indoctrination, conformalization, 'college spirit'. Looked at from Europe, however, one readily perceives an American look—a fluidity and responsiveness to the times that is less clearly seen in the older European foundations that depend on the State. In the past this fluidity was made possible by the University's freedom to dispose of its own income from endowment as it saw fit. With the new increase in cost and the decrease in income from investments, this freedom is now restricted. New things can still be done in such an American university, in part because resources from the great philanthropic foundations can be placed quickly at the disposal of persons with new ideas. Fortunately, this is now not restricted to American universities but is increasingly shared by learned institutions elsewhere. This, and the increasing participation of government and of industry in support of research through contractual arrangements, will surely profoundly affect the future of Columbia as of other universities.

AGRICULTURAL EDUCATION IN GREAT BRITAIN

FOR any adequate appreciation of the recent Report of the Working Party on Agricultural Education* some knowledge of the changes that have taken place during the past fifteen years is essential. Prior to the Second World War, agricultural education and advice to those engaged in any branch of the agricultural industry constituted a single service maintained by local government bodies—usually county councils—but financed mainly by the Ministry of Agriculture, not the Ministry of Education. A fraction of the cost was borne by the rates. The committee of the county council controlling the service was, as a rule, the Agriculture Committee, which often delegated this particular section of its work to an Agricultural Education Sub-Committee. In the dozen or so counties where an agricultural institute existed, this was normally controlled by the same body or a further sub-committee.

The chief officer of the county council responsible for the service was the agricultural organizer of agricultural education and, with rare exceptions, every county council had such an officer. His status in the hierarchy of county officials was high, often with the right of direct access to the clerk of the county council. Owing to the comparatively small number of agricultural organizers, it was also easy for them to have, unofficially, personal contacts with senior officials of the Ministry of Agriculture in London, which also maintained a small inspectorate. The whole set-up was a loose one—typically British—which worked brilliantly or dismally, depending on the county personnel—the officials appointed and the members of the Agricultural Education Sub-committee.

In some counties, a very fine system of agricultural education had been built up, with day and evening classes in various centres covering practically all the branches of agriculture and horticulture found within the county. The organizer, in addition, had his tasks of giving advice to farmers and other growers, visiting farms when necessary to take samples of soil, milk, feeding stuffs, etc. Also, he conducted demonstrations and experiments of various kinds on commercial farms, for example, on the manuring of grass or other crops, the feeding of livestock, comparison of varieties and the use of weed-killers.

A loose link-up between counties was provided by the provincial centre, situated at a university or agricultural college, as, for example, at the School of Agriculture, Cambridge, for the eastern counties. At the provincial centre there were specialists in chemistry, entomology, etc., on whose services the county organizer could call for the solution of problems which he could not solve himself. Quarterly meetings of the organizers and one or more members of their staffs, held at the provincial centre, provided occasions for the discussion of common problems, the drafting of co-operative experiments and numerous other matters. On the whole, the pre-War system of agricultural education in the counties was a happy one which, moreover, was capable of rapid development by taking the forward counties as a model and spurring on any laggard to approach the same level of achievement.

* Ministry of Agriculture and Fisheries. Report of the Working Party on Agricultural Education. Pp. 20. (London: H.M. Stationery Office, 1953.) 9*d*. net.

The proof of the system came with the Second World War. The agricultural officers of the local authorities were seconded as officials and advisers to the War Agricultural Committees, and it is not extravagant to claim that the tremendous advance made by British agriculture during the War was, in a large measure, due to the advice and help rendered to these committees by the local agricultural staffs.

In one sense they were too successful, for so impressed was the Ministry of Agriculture with their value as advisers—temporarily, through war-time regulations, under centralized control—that it decided, before the War ended, to set up a National Agricultural Advisory Service distinct from the County Agricultural Education Service. What had hitherto been one living—usually lively—organism was to be cut in two. This was done by the Agriculture (Miscellaneous Provisions) Act of 1944. It is doubtful whether any such Act could have been put on the statute book except in war-time, when the energies of those mainly concerned were concentrated on winning the battle for food production.

This new advisory service was planned to be set up, almost *in toto*, at a definite date, October 1, 1946, as a branch of the Civil Service with centralized control. Attractive salary scales were offered and those already engaged in agricultural education before the War were given the right of application for transfer. The alternative was to remain with the local authority with no definite salary scales and with very hazy prospects for the future.

These county staffs provided almost the only source of recruitment for the new advisory service; inevitably it practically denuded the counties of most of their experienced personnel and was an extremely serious blow for agricultural education. This function was now transferred to the Ministry of Education, which had no experience in this field. In the future, 'advice' was somehow or other to be differentiated from 'education'. Further, instead of agricultural education being an important activity of the Ministry of Agriculture, it became a very minor sector of the vast front of the Ministry of Education.

It is not an exaggeration to say that most of those connected with agricultural education—whether or not they transferred to the advisory service—deeply deplored the new system. The late Prof. N. M. Comber, when president of the Agricultural Section of the British Association in 1949, admirably expressed this view in the following words: "Those now engaged in the advisory service have no official colleagueship with those who teach agricultural students in Universities and Colleges, and the teachers have no longer their foretime association with all that is going on in the farming of today. These teachers are, therefore, deprived of what has been the main source of their life-blood as teachers, and the suicidal character of the whole development can be seen by anyone who gives thought about the training of those to be appointed to the Advisory Service staff in the next generation or so. This separation of teaching and advisory work is, in my view, a major tragedy in the history of agricultural education".

It is not surprising, therefore, that, in November 1952, six years after the formation of the National Agricultural Advisory Service, the Minister of Agriculture and Fisheries set up a 'working party' "To review the relations between the agricultural education service of Local Authorities and the National Agricultural Advisory Service, and to make proposals for their more effective co-operation; to examine the need for an inspectorate of agricultural education; and to consider the future of the Joint Advisory Committee on Agricultural Education". Unfortunately, these terms of reference excluded from its inquiry "major structural changes in responsibility for either education or advice on agricultural subjects". The setting up of the 'working party' disclosed the recognition of the existence of a 'dis-ease', but the 'working party' was strictly enjoined not to deal with the real cause of this disease, but merely to suggest measures for its alleviation.

Within such restricted terms of reference the working party in its report published in October last has made a number of minor, but useful, suggestions. Officers of the advisory and education service within each county are advised to meet together at least twice a year in order to organize better team-work and fuller collaboration in each other's activities. Similarly, the authorities responsible for the two sections of work are advised to have overlapping membership. A limited amount of secondment between the services is proposed in counties where staffs are large enough for it to be done. A small inspectorate of persons well qualified in agriculture or horticulture (but not members of the National Agricultural Advisory Service) is suggested. But the finding of greatest importance to the teaching side is that "suitably qualified L.E.A. staff are welcome to advise old students who are commercial producers, nor should they be debarred from advising other commercial producers if asked . . .". The final recommendation is that the Joint Advisory Committee on Agricultural Education, better known as the Loveday Committee, should lapse but be reconstituted when necessary for specific inquiries.

These results of a year's work by the twelve members of the Carrington working party are not very impressive; but in view of the terms of reference, it is difficult to think that the working party could have done better. H. W. Gardner

THE WORKERS' EDUCATIONAL ASSOCIATION

THE Workers' Educational Association has recently produced two publications which indicate the way in which Great Britain's most prominent voluntary organization in adult education is adapting itself to meet the challenge of new times and new men. The first is a review of the Association's activities since the end of the Second World War, and the second the report of a working party set up to inquire into Trade Union education*.

Looking back to 1920, the review shows how the Association has been tested in two world wars and emerged from both strengthened and revitalized. In 1913–14, there were 179 branches; 11,430 individual members; and there were 145 classes with 3,343 students. In 1919–20 there were 277 branches; 20,703 individual members; and there were 557 classes with 12,438 students. In 1938–39 there were 635 branches; 28,652 individual members; and there were

* Trade Union Education: a Report from a Working Party set up by the Workers' Educational Association. Pp. 120. 4s. 6d. The Workers' Educational Association. A Review 1946–1952. Pp. 84. (London: Workers' Educational Association, 1953 and 1954.)

3,306 classes with 58,735 students. In 1946–47 there were 932 branches ; 45,320 individual members ; and there were 5,516 classes with 100,373 students. The scale of this increase is impressive ; but its nature was very much influenced by the vast social changes brought about by the War itself. It was natural that the onset of war should hit the tutorial classes sharply ; but these later recovered. Many new students, however, saw in the short terminal course a means of satisfying their immediate need for information and discussion.

After the War a new situation arose. The opportunities for the rapid expansion of adult education which the immediate post-war years seemed to offer did not materialize to the degree that had been hoped. The flow of new students and members from the Armed Forces was disappointingly small. Except in the high proportion of short courses, the class programme of districts did not reflect the possibilities of expansion which new grant regulations offered. There were also distracting problems arising in districts from the effect of the Ministry of Education's new grant regulations on the work of university extra-mural departments and, to a less extent, of local education authorities ; a number of university extra-mural departments were anxious to avail themselves of their new power to extend their work rapidly in all directions and to enter fields hitherto reserved, by agreement, as well as by regulation, to the Workers' Educational Association. This introduced a new element into the Association—university relationships—and resolution of the difficulties to which it gave rise in districts was not easy.

Despite the Association's preoccupation with these matters, the number of classes and students continued to increase and, by 1948–49, there were 6,380 classes with 111,351 students in them, the highest numbers so far attained. The number of manual workers in classes had steadily increased since 1946–47, and in 1948–49 the number of tutorial classes, 889, had almost reached the highest figures of pre-war years.

At the same time the total membership of the Association was declining. From a maximum of 45,320 in 1946–47, the number of individual members declined year by year until in 1951–52 it stood at 34,628. There is no simple way of accounting on a national basis for this decline, particularly in view of the corresponding increase in the number of branches and the consequent increase in new members needed to man them. The record suggests that exceptional local conditions have produced district losses in membership which when taken into the national total have exaggerated the actual average decline for the districts together. There are signs, however, that general losses are coming to an end and that a stable and even increasing membership may soon be achieved.

The report also describes the kind of classes which were taken by students. In 1938–39, 58·38 per cent of all classes were concerned with the social sciences : by 1945–46 the proportion had risen to 63·60 per cent. Movement up and down in the two subsequent years was followed by steady increases to 55·2 per cent in 1951–52. Over the same period the proportion of classes in literature and the arts ranged from 25·8 per cent in 1944–45 steadily upward with only one check to 32·1 per cent in 1950–51. Philosophy lost ground in 1944–45 and 1945–46 (3·5 per cent) but rose to 6·9 per cent in 1949–50, before declining to 6·3 per cent in 1951–52. Science lost ground in the immediate post-war years (4·2 per cent in 1945–46), but increased slowly year by year to reach 6·7 per cent in 1951–52.

It is much more difficult to present the facts about the occupational background from which students have been recruited. Every year since 1946–47 the proportion of manual workers has decreased slightly from a maximum of 22 per cent in 1946–47 to 18·89 per cent in 1950–51. Those occupied with domestic and home duties increased steadily after the War but declined to 20 per cent in 1951. The proportion of clerks, draughtsmen and travellers declined steadily from 17 per cent in 1946–47 to 14·9 per cent in 1950–51. The proportion of teachers has increased from an average of 10 per cent from 1944–48 to 12·1 per cent in 1950–51.

Besides accounts of the Association's relationships with Trade Unions and its responsibilities in the national educational system as a whole, the review also deals with the relation of the Association to similar organizations in other countries, as well as the prominent part played by the Association in the formation of the International Federation of Workers' Educational Associations after the War.

The working party, which was set up under the chairmanship of the Right Hon. A. Creech Jones, was concerned with educational work for trade unionists in relation to the Trade Union movement. Its report shows that, in recent years, discussions of Trade Union education have taken a new turn. The development of nationalization, a renewed interest in what is loosely called 'workers' control', the growth of joint consultation and joint production committees, have led to an increasing interest in management studies and the administration of industry. The working party suggests that the real purpose of trade education in this field is to give active and representative trade unionists a closer understanding and a clearer grasp of the functions and problems of industrial administration. This will enable them to contribute more positively to the solution of the problems they are interested in, rather than merely pressing their claims regardless of their wider implications. This is particularly important where modern 'scientific management' techniques such as time- and motion-study and job evaluation are involved.

Among the subjects of study suggested by various Workers' Educational Association Trade Union advisory committees to the working party were the following : courses for branch officials, for shop stewards, and a general educational course ; courses in public expression, reporting-back, chairmanship, and secretarial practice, technical subjects such as incentive payment schemes, time- and motion-study, job evaluation, improvements in productivity ; the techniques of negotiation, joint consultation, the development of labour relations, human factors in industry ; Trade Union policy-making, wages structure and wages policy, the Whitley system ; business and industrial organization, statistics, the use of balance sheets ; Trade Union law and industrial law ; the Industrial Injuries Act ; the history and organization of particular Unions ; the new functions of Trade Unions and trade unionism in other countries.

A number of these advisory committees recommended that there should be special provision for the training of full-time Trade Union officers, while others felt that there is a need for educating young trade unionists in industrial relations, and in their

obligations to industry and to the Trade Union movement and its aims.

It was recognized that the demand for Trade Union education was very difficult to stimulate, and this was widely felt to be the fundamental obstacle to expansion. There was general agreement that full advantage was not being taken of existing facilities.

In considering the structure of Trade Union education it should be stated that the British Trade Union movement lacks a systematic structure and a fully authoritative and financially well-equipped co-ordinating body. It cannot do more than work gradually towards a complete and systematic union education. The individual Union will be for some time yet the unit of authority, of finance, and of educational policy, and the growth of Trade Union education and its co-ordination will depend on the relations of the educational bodies concerned with the Trade Unions the requirements of which have to be satisfied. The phases of Trade Union education in which the need for further development is obvious are: informal educational activities at the branch Trade Union meeting; training in the skills required in active work for the Trade Union movement; and the education of branch officers and lay representatives in practical and policy aspects of Trade Union action. A beginning has already been made in these directions, and further development depends on finance, supply of tutors, the use of appropriate methods, and the effective organization of the demand.

Experience already gathered in Trade Union classes shows the necessity for providing preliminary training in the 'tools of study' for some students selected for intensive courses. This has its impact on the general conduct of Trade Union business through the frustration which results when people are inadequately equipped to shape and express their opinions. The working party recommends that experiments should be carried out into ways of covering more adequately the legitimate demands for training in self-expression, meeting procedure, case preparation, and reporting, without encouraging glibness in public speaking or a tiresome obsession with procedure. Branch officers and lay representatives should also be trained in the practical skills involved in Trade Union action. These include secretarial practice, chairmanship, public speaking and the making of reports, committee and meeting procedure, the handling of documentary material and dealing with complaints and grievances.

The development of specific educational classes for trade unionists is beset by difficulties arising out of the Ministry of Education's grant regulations for adult education classes. These classes can be arranged by local education authorities on a grant-earning basis; they cannot be arranged by the Workers' Educational Association. What is needed is freedom for the Association to undertake development experimentally in various types of Trade Union education, and for this purpose to be able to disregard, within reason, the limits imposed by adult education regulations. It is important in Trade Union education to build on the immediate interests and experience of the students. Different types of approach will be required, and experience outside liberal adult education must be taken fully into account.

The supply of tutors for Trade Union education may easily become a bottleneck limiting or distorting development as the demand begins to grow. It is not known whether there are unused teaching resources which could be brought into action if an enlarged demand for Union education were experienced, and whether the supply could be increased by the provision of training courses. In developing the less academic types of Trade Union education it may be possible to draw on trained teachers who are not in universities or grammar schools, on Trade Union officers, and on others who have special knowledge or aptitude.

There is not a large number of university or Workers' Educational Association tutors who, in the post-war period, have made a special study of Trade Union questions, and only a minority will have had any industrial experience. If tutors are to do successful work in Trade Union education they should become familiar with the activities and policies of Trade Unions, and be able to gain the confidence of the people with whom they will work.

The working party also considered the part played by other organizations in Trade Union education, like the National Council of Labour Colleges and Ruskin College, and suggested that greater co-ordination would be achieved by setting up a central Trade Union education bureau, the function of which should be to collect and disseminate information about activities and experiments in the field of Trade Union education, to make available books, pamphlets and other educational material found to be needed, and, generally, to stimulate and to guide interest in Trade Union education in a variety of ways and to provide assistance to individuals and groups engaged in it.

T. H. Hawkins

OBITUARIES

Prof. F. C. Chalklin

Prof. F. C. Chalklin was born in 1902 and received his school education at Judd School, Tonbridge. He entered King's College, London, with a leaving exhibition and graduated in 1923 with honours in physics. For the four succeeding years he carried out research work on soft X-rays with Prof. (now Sir) Owen Richardson, obtaining the Ph.D. degree in 1926. He was appointed assistant lecturer in physics in the University of Sheffield in 1927 and three years later became a lecturer at University College, London. In 1939, two years after obtaining the D.Sc. degree, Chalklin was appointed a reader in the University of London. During the Second World War he was in charge of that part of the Physics Department of University College which was evacuated to Aberystwyth. Soon after the War, in 1946, he was appointed professor of physics in the University of New Zealand at Christchurch. It was on a visit back to Britain that the tragic air disaster at Singapore terminated a devoted and successful career.

Chalklin's experimental work was mainly concerned with the spectroscopy of soft X-rays, a subject in which he was a world authority. He built several grating spectrographs, with which he obtained valuable results. The greater part of his research work was carried out single-handed, or with the collaboration of his wife, Miss L. P. Davies, whom he met in the research laboratory at King's College, London. He had thrown himself with vigour into the task of building up a research school in Christchurch and his recent publications showed that much progress to this end had already been made.

Chalklin was meticulously careful as a research worker and equally so as a teacher and examiner. He was a very pleasant colleague to work with, always being anxious to take his full share of the work of a university department. His quiet and charming manner was associated with a friendly and sociable disposition. Although his natural enthusiasm was primarily devoted to physics, he possessed the Kentishman's love of cricket and of games in general —he played tennis and badminton.

Prof. Chalklin leaves a widow and three children (one son and two daughters). He will long be remembered by his former colleagues at University College, London, who have welcomed this opportunity of recording their appreciation of past associations with him and their deep sorrow at the untimely end to his career.

H. S. W. MASSEY

Mr. A. A. Pearson

By the death of Mr. A. A. Pearson on March 13, British mycology has sustained a great loss.

Arthur Anselm Pearson was born on April 12, 1874. He attended a school in Belgium for some years, but at the age of fifteen entered the firm of British Belting and Asbestos, Ltd., of which company he eventually became director and chairman. For the purpose of building up a large export trade, he set himself to learn foreign languages, and became a fluent speaker and writer in French, German, Spanish and Italian, an accomplishment which was also to be of great value in his scientific work. He took up the study of botany as a hobby, starting with wild flowers, but soon becoming attracted to the larger fungi. He loved foraying in the woods near his home, and was an excellent collector. At first he was interested in the lower Basidiomycetes, but later turned his attention more especially to the Agaricaceae, to the study of which he applied modern microscopic and chemical technique. He became well known both in Britain and abroad as an authority on the agarics, and during the season was kept busy naming specimens and answering queries sent by correspondents.

Pearson joined the British Mycological Society in 1911, and from 1919 until 1946 served the Society as its treasurer; he was president in 1931 and again in 1952, when he attended the foray held in Normandy in conjunction with the Société Mycologique de France, and delivered his presidential address in French. In 1946 he was made an honorary member of the British Mycological Society and in the same year was elected president of the Yorkshire Naturalists' Union. He became a Fellow of the Linnean Society in 1917. He was also a member of the Société Mycologique de France and of the Mycological Society of America. He regularly attended the forays organized by the British Mycological Society and also often those of the Société Mycologique, and was always most courteous and helpful to students who sought his assistance. After he settled at Hindhead, he became closely associated with the Haslemere Educational Museum, of which Mr. E. W. Swanton was then curator, and during the Second World War he took an active part with Mr. Swanton in collecting fungi to be tested at Oxford for the presence of antibiotics.

In 1948 he was invited by the Federal Government to visit South Africa in order to assist workers there in the study of the agarics of the Union. The result was an interesting paper describing many new species, published in the *Transactions of the British Mycological Society* (1950). Numerous scientific papers published between 1915 and 1950 have added much to our knowledge of the British fungus flora, and many of the younger mycologists use with gratitude his keys to various difficult genera.

In addition to his scientific work, Pearson was interested in music, and was known as a singer of unaccompanied folk-songs. On more than one occasion he filled in a blank evening at forays of the British Mycological Society by entertaining members in this way. His genial presence and his energy and helpfulness will be greatly missed.

E. M. WAKEFIELD

Mr. F. K. Goward

FRANK KENNETH GOWARD, who died on March 10, was a senior principal scientific officer in the Department of Atomic Energy. Born on August 30, 1919, he was educated at Queen Elizabeth's Grammar School, Wakefield, whence he was awarded a major open scholarship at St. John's College, Cambridge, in 1938. After only two years at the University, he took an honours degree in physics and, in 1940, he was directed to take part in the vital task of calibrating radar-chain stations. After service in Scotland, Mr. Goward joined the Telecommunications Research Establishment in Malvern in December 1942, where he quickly established a reputation as an able research worker.

Soon after the end of the War, Mr. Goward transferred to the staff of the newly formed Atomic Energy Research Establishment to take a leading part in the design of a novel particle accelerator, the electron synchrotron. By November 1946, collaborating with D. E. Barnes, he had established the validity of the new principle by accelerating electrons from 4 to 8 MeV. This was the start of a career of intense scientific activity during which Goward became an internationally recognized authority not only on the design of particle accelerators, but also in their use in (γ,n) studies of the nucleus. A man of remarkable energy, he took part in the design of the University of Glasgow 300-MeV. electron synchrotron, the 140-MeV. machine for the University of Oxford and the 30-MeV. machine at the Atomic Energy Research Establishment at Harwell.

In 1950 Mr. Goward was invited to attend a committee of scientists called together by Unesco. From these early discussions, plans were developed for an international laboratory under the auspices of the Council for European Nuclear Research (C.E.R.N.). In 1952 Mr. Goward was appointed deputy director of the group responsible for the design study of a proton synchrotron to give a proton beam with an energy greater than 10 GeV. By October 1953 the work had progressed to the stage when it was necessary to bring together the scientists working on this project. Goward was granted leave of absence to join the Council's staff, and moved with his family to Geneva. There he became active in the setting up and scientific direction of the Group. In February he became seriously ill and had to return to Britain.

Frank Goward was an outstanding young physicist; during his career he presented many scientific papers covering a wide field of research. His ability, combined with an irrepressible sense of humour, earned him great respect among his many friends and colleagues. We offer our deepest sympathy to his wife and two young children.

D. W. FRY

NEWS and VIEWS

Thermodynamics in the Imperial College, London : Prof. A. R. Ubbelohde, F.R.S.

Prof. A. R. Ubbelohde, head of the Department of Chemistry at The Queen's University, Belfast, since 1945, has been appointed professor of thermodynamics in the Imperial College of Science and Technology, London. Prof. Ubbelohde received his scientific training at Oxford, where he was a Senior Scholar of Christchurch during 1931–33, and later carried out research in collaboration with Sir Alfred Egerton in the Department of Thermodynamics at Oxford. After a year at Göttingen, he was appointed Dewar Fellow of the Royal Institution, and there began those investigations into the physical chemistry of the solid state with which his name is now so closely associated. During the War, he undertook experimental and theoretical investigations into the phenomena of explosion and detonation and made valuable contributions to accident prevention in ordnance factories. As head of the Department of Chemistry at The Queen's University, Prof. Ubbelohde has taken a prominent part in educational matters. He was dean of the Faculty of Science during 1947–51, and was largely responsible for planning the new Chemistry Department which is now in course of construction. He was one of the United Kingdom delegates to the Brussels Treaty Conference on University Education in 1953 and, in the same year, was a British Council delegate to the Technische Hochschule, Aachen. He was elected to the Royal Society in 1951. In addition to his numerous scientific publications, Prof. Ubbelohde is the author of "Modern Thermodynamical Principles", "Time and Thermodynamics" and a forthcoming book on "Man and Energy".

Physics at Bristol : Prof. M. H. L. Pryce, F.R.S.

Prof. M. H. L. Pryce has been appointed Henry Overton Wills professor of physics in the University of Bristol in succession to Prof. N. F. Mott, who is going to the Cavendish chair at Cambridge (see *Nature*, December 19, p. 1128). Prof. Pryce has been Fellow and lecturer at Trinity College, Cambridge, reader in theoretical physics in the University of Liverpool and Wykeham professor of physics in the University of Oxford, to which post he was appointed in 1946. During the Second World War he worked in the Admiralty Signals Establishment and on atomic energy at Montreal, and since the War he has acted as consultant to the Atomic Energy Research Establishment at Harwell in matters concerned with theoretical physics. He has also been visiting professor at Princeton. His research work has been on field theory and on the structure of the nucleus; since he went to Oxford he has turned his attention also to paramagnetism, particularly at low temperatures, and to the theoretical aspects of much of the work of the Clarendon Laboratory. At Oxford Prof. Pryce has built up a flourishing school of research on these subjects, in which the students are encouraged to work in the laboratory in the closest contact with experiment; many of his pupils are already in demand for responsible posts. As a leader of research in theoretical physics he belongs to the school which believes that, while experiment cannot flourish without theory, theory can rarely, if ever, flourish without experiment.

Bacteriology at Aberdeen : Prof. John Cruickshank, C.B.E.

Prof. John Cruickshank, who retires in October, has occupied the chair of bacteriology in the University of Aberdeen since it was founded in 1926. A graduate in medicine of the University of Glasgow, Prof. Cruickshank had previously held appointments in the Pathology Department at Glasgow, when he was one of the brilliant group of workers trained by Sir Robert Muir, and at the Crichton Royal Institute, Dumfries, where he was pathologist. During the First World War he was assistant advisor in pathology to the Third Army in France. Before his appointment to the chair, he held the McRobert cancer research fellowship in the University of Aberdeen. A member of the Pathological Society of Great Britain since 1909, Prof. Cruickshank has often delighted members by the skill of his own communications and by his lively and sometimes trenchant criticism of the work of others. He was a member, for a number of years, of the Bacteriological Committee of the Medical Research Council. He took part in the early work in Great Britain on the Wassermann reaction and on the colloidal gold reaction with cerebro-spinal fluid, and his study, with Prof. Robert Cruickshank, of the normal intestinal flora of man remains one of the best accounts of this subject. Prof. Cruickshank has never been diverted by the latest, and often ephemeral, phases of bacteriological research but has continued his work on luminous organisms and the soil bacteria which show mass migration on agar. For his work in organizing blood transfusion in the north-east of Scotland and for his investigations on the bacterial break-down of cellulose, and particularly on methods for the preservations of paper under adverse conditions in the tropics, he was made C.B.E. in 1946.

Dr. A. Macdonald

Prof. Cruickshank will be succeeded at Aberdeen by Dr. A. Macdonald, at present reader in bacteriology in the University of Liverpool. Dr. Macdonald graduated in medicine from the University of Aberdeen in 1937, and was later Garden Research Fellow in bacteriology there, gaining his M.D. and the Thursfield Award in 1943 for his work on the pathogenic staphylococci. He joined the Emergency Public Health Laboratory Service in 1942 in Cambridge, and the following year was appointed director of the new constituent laboratory of this Service in Norwich, where he worked on food-poisoning and on other bacteriological problems of public health importance. In 1948 he joined the staff at Liverpool as reader in bacteriology, working with Prof. A. W. Downie's team on the pox group of viruses, and he has also investigated congenital toxoplasmosis and human infections with the virus of contagious pustular dermatitis. Last year he was at the Pasteur Institute in Paris, where he was concerned with the newer tissue culture techniques used for the study of poliomyelitis and other viruses. Dr. Macdonald is an assistant editor of the *Journal of Pathology and Bacteriology*, the official journal of the Pathological Society of Great Britain and Ireland.

University College of North Staffordshire

The University College of North Staffordshire will confer degrees for the first time on July 3. The College received its Charter in 1949 and is empowered

to confer the degree of bachelor of arts. The first students were admitted in 1950 and will complete their four-year course of study next term. The ceremony will take place in the College Hall at Keele.

European Convention on the Equivalence of University Entrance Examinations

REPLYING to a question in the House of Commons on March 29, Mr. Anthony Nutting, Joint Under-Secretary of State for Foreign Affairs, stated that the United Kingdom instrument of ratification of the European Convention on the Equivalence of University Entrance Examinations was deposited with the Secretary-General of the Council of Europe on March 22, 1954. Copies of the Convention were presented to Parliament on January 12 as Command Paper 9039. Under the Convention, for the purpose of admission to universities in its territory that are subject to State control in the matter of entry, each contracting Government undertakes to recognize the equivalence of those diplomas awarded in the territories of the other contracting parties which constitute a requisite qualification for admission to similar institutions in those territories. Admission to any university is subject to the availability of places; and the Governments undertake to transmit the text of the Convention to universities in their territory that are not subject to State control in the matter of entry, and to endeavour to obtain acceptance of the principles of the Convention by such universities.

Information on Atomic Weapons

IN a statement in the House of Commons on March 23, the Prime Minister said that there was a constant interchange of ideas between H.M. Government and the U.S. Government both direct and through N.A.T.O., and that he had had intimate correspondence and conversations with President Eisenhower on the group of stupendous problems and perils comprised in atom and hydrogen bomb developments. After commenting on the remarkable restraint of the Press, he said that he hoped and trusted that the nation and thinking people in it would not in any way under-rate the overwhelming consequence of the developments which are taking place. Answering questions in the House of Commons on March 30, Sir Winston added that our knowledge of the American experiments is necessarily limited, and the U.S. Government is prevented by its own legislation from divulging secret information about them. From our own scientific knowledge he could say that there is no foundation for the suggestion that these explosions are "incalculable" in the sense that those making the tests are unable to set limits to the explosive power of the hydrogen bomb or to calculate in advance what the main effects will be. The restrictions imposed by the United States law also make it impracticable for further tests to be the subject of international consultation or control; but he hoped that it would be found possible within the limits of existing U.S. legislation to give us information about what occurred in the present test series. With regard to the suggestion that he should attempt to persuade the U.S. Government to abandon this series of experimental explosions of hydrogen bombs, he said we have no power to stop this. No satisfactory arrangements could be made to limit the use of atomic weapons except as part of an international agreement on disarmament as a whole, and there could be no security in such an agreement unless it included provision for effective inspection and enforcement.

The agreement between the United States and the United Kingdom Governments relating to atom bomb research and development, made at Quebec in August 1943, to which the Prime Minister referred in his subsequent speech in the House of Commons on April 5, has been published as a White Paper (Cmd. 9123). After agreeing that the atom bomb would not be used against third parties without each other's consent and that information relating to it would not be communicated to third parties except by mutual consent, it provided for full and effective interchange of information and ideas relating to scientific research and development between those in the two countries engaged in the same sections of the field, as well as for complete interchange of information and ideas on all sections of the project between members of the Combined Policy Committee set up in Washington, and their immediate technical advisers.

Oxford Meeting of the British Association

THE preliminary programme has now been issued for the Oxford meeting of the British Association to be held during September 1–8, under the presidency of Dr. E. D. Adrian, whose presidential address will be on "Science and Human Nature". The presidents of sections and the titles of their sectional addresses are as follow: Section A (Mathematics and Physics), Sir John Cockcroft, "Recent Developments in High-Energy Physics"; Section B (Chemistry), Sir John Lennard-Jones, "New Ideas in Chemistry"; Section C (Geology), Dr. C. J. Stubblefield, "The Relationship of Palæontology to Stratigraphy"; Section D (Zoology), Dr. G. R. de Beer, "Archæopteryx and Evolution"; Section E (Geography), Prof. J. A. Steers, "The Coast and the Geographer"; Section F (Economics), Prof. E. A. G. Robinson, "The Changing Structure of the British Economy"; Section G (Engineering), Dr. Willis Jackson, "New Materials in Engineering"; Section H (Anthropology and Archæology), Sir Mortimer Wheeler, "Archæology in Africa"; Section I (Physiology), Prof. A. D. Macdonald, "The Relief of Pain"; Section J (Psychology), Prof. L. S. Hearnshaw, "Recent Studies in the Psychology of Thinking"; Section K (Botany), Prof. W. H. Pearsall, "Growth and Reproduction"; Section L (Education), Mr. Ronald Gould, "The Teacher in the Twentieth Century"; Section M (Agriculture), Dr. R. E. Slade, "Agriculture: the Industry and the Science"; Section X (Assembly of Corresponding Societies), Dr. C. B. Williams, "Phenology: the Sequence of Events in the Biological Seasons". Copies of the programme can be obtained from the Secretary, British Association, Burlington House, Piccadilly, London, W.1.

Handbooks for Museum Curators

THE museum profession has always lacked a complete series of authoritative handbooks describing accepted principles concerning administration, display and technique in museums and art galleries. True, that in geology and certain other matters with which the museums are concerned there are outstanding exceptions but, by and large, students for the diploma of the Museums Association and indeed those more senior in the vocation lack accredited text-books. To meet this need an editorial panel of distinguished directors and others under the chairmanship of Dr. D. B. Harden has been entrusted with the production

of a series of handbooks for museum curators. The scheme is ambitious and comprehensive and is divided into seven parts under the following headings: administration, museum technique, archæology, ethnography and folk-life, art, natural and applied sciences, temporary activities and the museums schools services. Each part has a separate editor and is further divided into sections dealing with different aspects of the subject. The scope thus covers the whole field of museum administration and practice. Obviously it will not be possible for the parts and sections to be published in any planned order; but a uniform format is to be observed throughout, and the individual booklets have a sufficient inner margin to be held in loose binding covers.

The first of the set to be published is by Dr. A. A. Moss, now in the Department of Mineralogy at the British Museum (Natural History) and previously at the research laboratory of the British Museum at Bloomsbury, "The Application of X-rays, Gamma-rays, Ultra-violet and Infra-red Rays to the Study of Antiquities", by A. A. Moss (pp. 16, 9¾ × 7⅓ in.; 4*s*., 3*s*. to members of Museums Association. London: Museums Association, 1954). It has been numbered Section 4 of Part B (Museum Technique) and deals with a practical account of processes in the study of antiquities which can be carried out in a museum laboratory. It is illustrated by eight pages of half-tone plates and one line drawing which vividly demonstrate the detail which is revealed by an examination of objects by wave-lengths outside the limits of visible light. It shows, for example, how the use of X-rays demonstrated the existence of pattern welding in the Sutton Hoo iron swords and silver inlaid ornament in corroded buckles. Dr. Moss also deals with the examination of porcelain, books and manuscripts by ultra-violet and infra-red rays, whereby flaws and otherwise invisible breaks may be detected. The value of such processes in establishing the authenticity of objects is considerable, and the booklet will appeal to those interested in antiques, *objets d'art* or manuscripts. There are many references to earlier papers and a useful bibliography. We unreservedly commend the booklet to curators and would-be curators of museums and art galleries and indeed to all those interested in antiquities.

Soloman R. Guggenheim Museum, New York

The December issue of the *Museums Journal* states that the Soloman R. Guggenheim Museum is about to be commenced in New York. This spectacular building is in essence a cylindrical structure, rather wider at the top than the bottom, and comprises a continuous gentle ramp spiralling upwards, like a spring, around a central circular well. A shallow dome of concentric rings of glass tubing is supported over the well on a steel and aluminium frame and allows light to penetrate down the centre of the building and be diffused between the coils of the ramp, which are open-sided, on to the well, like a theatre balcony. Visitors will go by lift to the top and then walk down by way of three-quarters of a mile continuous ramp, the greater part of which will be exhibition space and can be divided by movable screens into rooms and alcoves. Visitors may, moreover, enter or leave at one point on each circuit where a smaller cylindrical structure contains lifts and a steeper, staircase-like ramp. Of particular interest is the almost unbroken window slit running around the top of the outer wall of the gallery and designed to provide both natural and artificial illumination. A lecture theatre occupies the basement, and adjacent groups of buildings provide offices, storage and living quarters for the director. The architect of this revolutionary structure is Mr. Frank L. Wright, of New York.

Shortage of Science Teachers: New Committee of the Federation of British Industry

The serious effect on industry of the shortage of science teachers in schools was the subject of a conference of educationists and industrialists organized by the Federation of British Industries in January, and a resolution passed at the conference recommended the Federation to set up a committee, representative of education, industry and other employers of scientists, with the aim not only of improving the supply of science teachers to the schools during the difficult years 1955–60, but also of seeking a permanent solution to the problem. Following this recommendation, the Federation has formed a Committee on the Shortage of Science Teachers, of which Dr. Percy Dunsheath (chairman of the Federation's Education Committee) will be chairman, supported by nineteen other members, each of whom will be serving in a personal capacity, and with two observers from the Ministry of Education. The nineteen members are drawn from various bodies as follows: five from schools, three from universities, one from a technical college, seven from private industry and three from government and nationalized industry.

Measurement of Humidity

The fourth in the series of "Notes on Applied Science" prepared by the National Physical Laboratory, Teddington, deals with the "Measurement of Humidity" (pp. 20. London: H.M.S.O., 1953; 1*s*. net). The measurement of humidity in the open air for meteorological purposes, which is well described in booklets issued by the Meteorological Office, is not discussed, nor are humidity measurements at very low temperatures or at high altitudes in the atmosphere for which special methods and suitable hygrometers have yet to be devised. However, humidity has to be controlled in many enclosed spaces, such as art galleries, tobacco warehouses, egg stores, textile factories and conditioning rooms. For this, high accuracy in the determination of the relative humidity is not required, and there are many types of hygrometers available to choose from. The booklet explains the physical principles underlying the various types, including wet- and dry-bulb hygrometers, dew-point instruments, and mechanical, gravimetric and electrical hygrometers, and gives detailed descriptions of some of the instruments and their particular applications. It also contains some remarks on the choice of hygrometer and instructions on the calibration of the instruments, some types of which require frequent calibration. Finally, in appendixes, definitions and references to tables of data and more detailed information are given.

Council for the Promotion of Field Studies

Despite its preoccupation with finance, the Council for the Promotion of Field Studies is able to write in its report for 1952–53 that "its teaching work has continued and extended, and it is acknowledged on all sides to be of high value and significance. We can fairly claim now to have done our part to foster a method and tradition in field studies and to have made some contribution to overcoming the

admitted practical difficulties of such work". At Dale Fort, 917 spent a week at the centre during the year, this being 228 more than in the previous year. Of these, 621 were biologists, 137 geographers, while the remainder pursued other studies. The proportion of amateur naturalists rose steeply; but sixth-form school students were still the largest category. Despite excellent facilities for botanical studies, in 1953 only one party of botanists made use of the centre. Flatford Mill also reported an increase in numbers attending, and this despite the effects of the east coast floods in January 1953. At Juniper Hall there was an increase of a hundred students over the previous year, 10 per cent of the total attendance being made up of students from Germany, and various individual students and workers attending the centre independently of educational institutions. The largest number of students at any centre was at Malham Tarn, which had a total of 1,132: one of the main events during the year at this centre was the annual field meeting of the British Ecological Society in July 1953.

In spite of the Council's fine record, however, the financial situation is causing the executive committee continuing concern, and its chairman, Prof. S. W. Wooldridge, appeals for financial support from those who believe in its aims and approve its methods. Without increased financial support the Council can neither contemplate any improvement of its work, however modest, nor, what is perhaps even more important, get such relief from unremitting financial pressure as might enable officers to plan a little way ahead.

Higher Education in China

THE visit of a party to China in 1952, made up of members of Parliament, university professors, men of science, doctors, journalists, lawyers, actors, trade union officials and an architect and a musician, is described by Dr. D. M. Ross, a member of the party, in a recent issue of the *Universities' Review* (**26**, No. 2; February 1954). The party went as guests of the Chinese People's Institute of Foreign Affairs, and those interested were able to visit a number of universities and talk to many university teachers during the month they spent in China. Dr. Ross reports that "the stage is set for advances in higher education in that country of staggering dimensions". Within twenty years university students in China should be counted in millions, and university teachers in tens, or hundreds, of thousands. In another article, Dr. F. C. Jones discusses the way in which Chinese university teachers have fared under sovietization. Some, perhaps the wisest, have fled to the United States. Others have resisted and have been dismissed, imprisoned or driven to suicide. Most have submitted, some through successful indoctrination, others because they have to live. Dr. Jones believes that the Chinese university teacher "will continue to be deprived of all real freedom of thought or expression; he will be compelled to teach what he at heart knows to be false and he will not be permitted even silent disapproval". He will also have a minimum of contact with the outside world, save only the Soviet Union.

Bibliography of Seismology

THE very valuable "Bibliography of Seismology", comprising both pure and applied branches of the subject, and compiled by W. G. Milne, continues to be issued by the Dominion Observatory, Ottawa (Vol. 14, Nos. 9–12; 1952–53. Ottawa: Queen's Printer; 25 cents each number). The bibliography is as complete as the author can make it, and co-operation is invited. Items in recently published numbers include some from the U.S.S.R. and an increasing number from Turkey. During 1951 most entries in the bibliography were concerned with, in order, seismic prospecting, wave studies from observations, and general description of earthquakes; whereas during 1952 they were about wave studies from observations, mathematical physics applied to seismology, surface waves, seismic prospecting and studies of the earth's crustal structure. Considerable interest is at present evident among seismologists concerning the possibility of low-velocity layers in the upper part of the earth. Earthquakes giving good instrumental records at epicentral distances up to 30° are being studied for evidence of these layers, and the theoretical aspects and consequences of such possible layers are being considered. Notes and papers on this topic are listed in the bibliography, including work by Gutenberg, Jeffreys, Stoneley and others. A paper listed as item 7985 by Jean De Bremaecker, "Amplitudes of P_n waves from 3° to 23°" (abstract) (*Bull. Geol. Soc. America*, **63**, No. 12, Part 2, 1350; December 1952), also calls to mind the very valuable new seismograph station at Lwiro in the Belgian Congo. There is room for many more seismograph stations in Africa.

New Spitsbergen Ostracoderms

A RECENT publication, "Morphologic and Systematic Studies of Spitsbergen Cephalaspids", by Gustav Wängsjö (The Downtonian and Devonian Vertebrata of Spitsbergen, IX. Part A, pp. 615. Part B, pp. 42 and 118 half-tone plates. Norsk Polarinstitutt, 1952), brings to mind E. A. Stensiö's remarkable work on the same group in 1927 which marked the beginning of a new era in our knowledge of the Ostracoderms. A great deal of investigation has been done since then, much of it by Stensiö's school or under his inspiration. Two expeditions have brought back considerable collections from Spitsbergen, that of Th. Vogt in 1928 and the English–Norwegian–Swedish expedition under the leadership of Stensiö in 1939. A thorough examination of this, together with a reinvestigation of Stensiö's material where desirable, has enabled G. Wängsjö to record sixty-three new species of cephalaspids and to provide further information concerning a number of others. The use of new techniques, including staining with alizarin, revealed many details of the anatomy, internal and external, and the author devotes 205 pages to this aspect and makes valuable additions to our knowledge. When discussing the phylogenetic relationships of the group, Stensiö divided the Ostracodermi (primitive cyclostomes) into two groups, the first containing the Petromyzontes, Anaspida and Osteostraci, and the second containing the Myxinoidea, Palaeospondylus and the Heterostraci. This, as will be seen, divides the living cyclostomes between two widely separated groups. Subsequent work has modified this suggestion. First, Palaeospondylus has been removed from the Agnatha and placed with the Gnathostomata; secondly, the myxinoids are considered so closely related to the petromyzonts that they must be included in the same order; and lastly, the Heterostraci are now regarded as well removed from the others with which they have only a remote connexion. With these views the author is in agree-

ment, and his suggested classification is to divide the Agnatha into two major groups: (1) Diplorhina (Pteraspidomorphs of Stensiö), and (2) Monorhina (Cephalaspidomorphs), with three orders, Osteostraci (cephalaspids), Anaspida and Cyclostomata. The memoir is lavishly illustrated by 108 text figures and 300 photographs on the 108 plates, and it has an extensive bibliography.

Sexual Behaviour and Spawning of the Squid

It has long been known that the Pacific Coast squid *Loligo opalescens* tends to migrate to certain inshore areas for spawning. An unusually large spawning population of *L. opalescens* appeared in the La Jolla area of California during February and March 1953 and gave John A. McGowan an opportunity to make direct observations in the field (*California Fish and Game*, **40**, No. 1; January 1954). The sequence of events in the spawning of *L. opalescens*, based on the above observations and on those of other authors, seems to be as follows. First, a population which is ready to spawn moves from offshore into a relatively shallow area near shore. It seems probable that at this time the males transfer sperm to the buccal seminal receptacles of the females. Then the squid tend to congregate near the sandy bottoms of semi-protected bays. A few minutes before the females lay their eggs, the males transfer a second group of spermatophores to a place under the left side of the mantles of the females. Finally, the females attach their egg capsules either to the sandy bottom or to the base of some previously laid egg capsule. This results in large masses of egg capsules, which may be as much as forty feet in diameter. It has also been observed that both males and females die after spawning and that the eggs require 30–35 days to hatch at a temperature of 13·6° C.

Symmetry of the Bean Shoot

The symmetry of the shoot in *Vicia faba* and some related species and the transmission of 'morphogenetic impulses' in the shoot have been discussed by K. J. Dormer (*Ann. Bot.*, N.S., **18**, Jan. 1954). Axillary buds occur in unsymmetrical arrangements so that any node must be either right- or left-handed. The two types occur in roughly equal numbers but are not randomly distributed. The condition of any node is determined partly by stimuli transmitted from the nodes below. The tissues of the stem can act as a filter, transmitting right- and left-handed stimuli with different degrees of efficiency. Although there are considerable interspecific differences in respect of these relationships, it is unlikely that the actual state of right- or left-handedness of a node is subject to any direct genetical control. In this respect the bud arrangements resemble phyllotactic spirals and differ from most other right- or left-handed structures occurring in plants.

The Biological Council

Dr. J. L. Cloudsley-Thompson, honorary secretary of the Biological Council, writes: "In their article on the 'Natural History of the Learned and Scientific Societies', Cohen, Hansel and May (*Nature*, **173**, 328; 1954) state that in 1944 the Biochemical Society 'initiated the Biological Council, which includes the Physiological, Anatomical, Pathological and Linnean Societies and the Society for Experimental Biology'. This list should be amplified to include the Association of Applied Biologists, the Association for the Study of Animal Behaviour, the Biochemical Society, the Biometric Society (British Region), the British Mycological, Pharmacological and Physiological Societies, the Marine Biological Association, the Nutrition, Royal Entomological, Royal Horticultural and Royal Microscopical Societies, the Societies for Applied Bacteriology, Endocrinology and General Microbiology, and the Institute of Biology. The Royal Society sends an observer to meetings of the Council. The Council was founded in 1944. Its purpose is to provide a common meeting ground for representatives of the principal biological societies, which will enable them to co-operate in matters that concern them jointly and to advise the Institute of Biology on such matters".

Commonwealth Fund Fellowships: Awards

Commonwealth Fund Fellowships, tenable by British graduates in American universities for one year beginning next September, have been awarded to the following, among others: T. W. Bloxam, Universities of Edinburgh and Glasgow (geology); G. M. Brown, University of Durham and University College, Oxford (geology); T. N. Clifford, University of Leeds (geology); P. R. Day, Birkbeck College, London (plant pathology); L. T. Evans, Brasenose College, Oxford (agriculture); I. M. James, Queen's College, Oxford (mathematics); J. D. Jukes, St. John's College, Cambridge (engineering); W. Mackenzie, University of Glasgow and Balliol College, Oxford (philosophy); L. Mestel, Universities of Cambridge and Leeds (astrophysics); H. P. F. Swinnerton-Dyer, Trinity College, Cambridge (mathematics); A. J. Weir, University of Glasgow (psychology); C. H. Wood, School of Tropical Medicine, London (medicine); and E. C. Zeeman, Caius College, Cambridge (mathematics).

Announcements

The Council of the Royal Astronomical Society, at its meeting on April 9, elected the following to associateship: Prof. J. Dufay, director of the Observatory of the University of Lyons; Prof. M. Waldmeier, director of the Eidgenossische Sternwarte, Zurich; Prof. H. Zanstra, director of the Astronomical Institute of the University of Amsterdam.

The following have been appointed to lectureships in The Queen's University of Belfast: Dr. H. Schneider (pure mathematics); Dr. J. Lowy (experimental zoology); and Dr. H. G. Heal (chemistry).

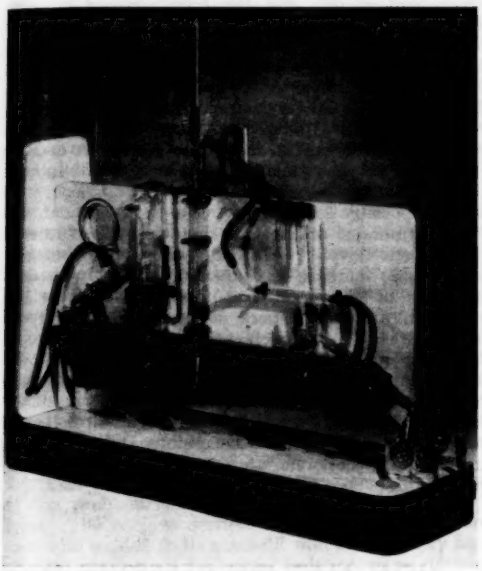
The Executive Council of the Commonwealth Agricultural Bureaux has elected Mr. W. F. C. Morton, representing the Union of South Africa, as its chairman, in succession to Dr. E. Marsden, the New Zealand representative.

Mr. H. B. Toft has resigned from the principalship of Bath Technical College to take up an appointment in industry with A. Gallenkamp and Co., Ltd., scientific apparatus and instrument manufacturers. Mr. Toft served during the War in the R.A.F. as a signals officer and in the Directorate of Radar.

A symposium on "Creep and Fracture of Metals at High Temperatures" will be held at the National Physical Laboratory during May 31–June 2. Because of limitation of accommodation, attendance will be by invitation; those interested in being present are asked to write to the Director of the National Physical Laboratory, Teddington, Middlesex. A registration fee of 25*s*. per person will be payable.

APPARATUS FOR SEMIMICRO ORGANIC CHEMISTRY

DR. J. T. STOCK AND MR. M. A. FILL, of Norwood Technical College, Knight's Hill, London, S.E.27, are well known for their development of ingenious microchemical apparatus for use in analytical and physical chemistry. Some of this apparatus was exhibited at the International Congress on Analytical Chemistry held in Oxford in 1952. Dr. Stock and Mr. Fill, however, have not neglected the field of organic chemistry, and in the course of several years have developed a compact assembly of specially designed apparatus that covers all the general operations of preparative work and identification on a semimicro scale (cf. *J. Chem. Educ.*, **30**, 296; 1953).



The value and utility of this assembly has now been increased by fitting the glass components with standard interchangeable ground-glass joints, and this 'vest-pocket laboratory' is being marketed by Quickfit and Quartz, Ltd. The assembly is mounted on a wooden stand, surfaced with 'Formica' laminated plastic sheet, and has a gross weight of only 14 lb. (30 in. long, 8 in. deep and 18 in. high). The base incorporates two drawers, inside which are test-tube racks and room for spare apparatus and thermometers. The handles are shaped to form additional test-tube racks. The sixty-one glass components are based on a shortened B10 joint and are held in place by Terry clips, which permit easy removal. All that is required for operation is a single connexion to a water supply, one or more simple micro gas-burners, and connexion to a vacuum for certain operations.

On the side of the centre board not visible in the illustration, the assembly incorporates a water-bath with 'ears' to support test-tubes and beakers for evaporation, a pipette for dispensing reagents and for assisting evaporation of solvents, a reflux apparatus with pear-shaped flask and all-glass Liebig condenser (these items form the basis of the apparatus), a three-necked flask with dropping funnel and a reflux condenser for carrying out reactions, a melting-point apparatus, a continuous percolator for the extraction of solids, and a unit for distillation at ordinary pressure with a fraction collector. On the other side of the centre board are a steam-distillation unit with an anti-suck-back device, a fractional distillation unit with a simple air-jacketed column and fraction collector, and a vacuum distillation unit with a 'pig' fraction collector. On the left-hand end of the assembly are two Willstätter and one Schwinger filters, a drying tube to fit the filters, an ice bath with 'ears' to support test-tubes, and a separating funnel.

The unit and its components bear the stamp of having been designed and made by chemists familiar with the operations to be carried out in the apparatus. The design has not suffered in the change from corks to ground-glass joints. Very often so-called micro and semimicro apparatus with ground-glass joints is practically useless through unpractical design and an unsuitable size of joint.

This assembly clearly has many possible uses. It appears particularly suitable for introducing a student, in the course of his undergraduate training, to the techniques of semimicro-scale preparative organic chemistry. In this connexion Dr. Stock and Mr. Fill have devised and used a course of experiments covering all the ordinary operations of preparative organic chemistry. This assembly, too, should be useful in research work; here the components could be used separately or easily varied by the research chemist himself for particular purposes. The assembly has many uses other than for teaching; for example, in static or mobile laboratories needing to perform organic analytical operations and, in the event of war, for the investigation (at regional level) of chemical warfare agents. S. H. HARPER

COLOMBO PLAN FOR SOUTH AND SOUTH-EAST ASIA

INTERIM REPORT

ONE-THIRD of the six-year period 1951–57 laid down for the original Colombo Plan programmes has now elapsed, and the recently published second annual report of the Consultative Committee on Economic Development in South and South-East Asia (New Delhi, October 1953. Cmd. 9016. London: H.M.S.O.; December 1953; 3*s*. 6*d*. net) attempts to take stock of the situation and the progress achieved. It was realized that the full achievement of the original objectives, which are still regarded as conceived on the right lines, would do little more than hold the existing position, because of the high rate of increase in population and the inadequacy of savings and capital investment. The population of the area, already between six and seven hundred millions, is growing at the rate of about eight millions a year; thus even to maintain present standards a continued increase in output is required, and the urgent need is to produce more food, both by opening up new

land and by increasing the yields from land already under cultivation.

The programmes of the Colombo Plan countries can now be considered as having generally passed out of the stage of preparation into that of execution; but broadly they are only just reaching the stage when tangible returns on any considerable scale can reasonably be expected. Most countries have devoted a large proportion of their programmes to measures which will directly or indirectly increase agricultural output. Improved means of communication and increased sources of power are also basic forms of investment and are essential whatever changes may be made from time to time in the general structure of the economy. The report also stresses the importance of developing human resources; but although not all the programmes include expenditure on such social welfare projects as health, education and housing, which would generally be regarded as adequate, the report recognizes that each country must decide for itself to what extent the growth of social capital should be promoted immediately at the cost of withdrawing capital from more-productive fields.

The successful execution of the individual development plans depends on the extent to which the main components required—capital goods, trained men and finance—are or can be made available, and each country needs continuously to review its development programme in the light of such available or anticipated resources. Although prices are still high in relation to 1950 levels, the supply of capital goods, provided that finance is available, is not expected to present undue difficulties. As regards trained manpower, the report notes a closer relationship between capital development and technical co-operation, as well as a tendency towards a better balance between training at home and training abroad. The short-term emphasis on the preparation and execution of plans which will result in increased production in the shortest possible time has encouraged in some countries much reliance on experience and techniques which are at present only available from abroad, whereas longer-term interests demand the development of training facilities in the countries of the region to provide the millions of medium- and lower-grade technicians who will be required in every branch of industry and administration and who can only be trained in their own countries.

Technical co-operation funds have in consequence been used for establishing and equipping training institutions; although it takes time to develop institutions of this character, unless a start is made now some of the projects already launched may wither away for lack of a supply of trained technicians to operate and expand them. The Technical Co-operation Scheme may have a special part to play also in the provision of equipment for such training institutions. Moreover, the basic concept of the Colombo Plan has been co-operation, with each country doing what it can to assist in the development of the area as a whole. Development schemes in operation in any particular country of the region are likely to be repeated elsewhere with certain modifications, and planners, managers, engineers and trainees can often learn more from such a project in the area than from a completed project in a developed country where conditions may differ widely from those in the region. To promote this kind of training, the Council for Technical Co-operation has agreed that capital expenditure on buildings is a proper charge on a country's contribution to the scheme, provided that substantial benefits are offered to other countries in the area.

The third factor—finance—presents the greatest difficulty; the countries of the region no longer enjoy the very favourable terms of trade which prevailed for most of them in 1950–51. The prices of most of the exports in 1952–53 had fallen considerably, the terms of trade appreciably worsened and public revenues decreased, while budget deficits replaced, or threatened to replace, the overall budget surpluses of the boom period. Under these conditions, the Governments concerned maintained or increased their expenditure on development only by drawing heavily on their reserves, by external aid in the form of loans or grants, or by raising internal loans. Some even engaged in deficit financing, by borrowing from the banking system to meet their current expenditure.

The risk of inflation is inherent in any intensive investment effort; but the report points out that deficit financing seriously aggravates this risk—because the consequences of inflation are particularly serious in most countries of the area, deficit financing can only be used to a limited extent. The Colombo Plan programmes are, it is concluded, reaching a critical stage, and their success depends on, besides concentration on the essentials and the fullest use of all available resources, sound internal policies designed to check inflation and secure the highest possible level of saving and investment, and the continuance of external financial aid at least at its present level. Although there has been an appreciable increase in domestic private investment in most of the countries, foreign capital is also required, and the report suggests that a hopeful approach is to invite such capital on a specific project basis on mutually agreeable terms. Finally and significantly, the report notes that the dependence of the area on world markets means that the success of plans for future development largely turns on the outcome of international discussions and the reviews of national economic and trade policies currently proceeding.

NEW NATURE RESERVES IN GREAT BRITAIN

THE following six areas in England were declared as new nature reserves on March 9 by the Nature Conservancy: the 514 acres of the Woodwalton Fen, Huntingdon; the addition of 10 acres, known as West Wood, to the Monk's Wood Nature Reserve, already declared on July 1, 1953; the 1,628 acres of sand-dunes, salt marsh and shingle ridges at Scolt Head, Norfolk, acquired by the National Trust in 1923, to which a further 197 acres will shortly be added; the 246 acres of shingle spit at Orfordness and the adjacent 264 acres at Havergate Island of the Orfordness–Havergate Nature Reserve on the Suffolk coast, under agreement with the Royal Society for the Protection of Birds; 140 acres at Old Winchester Hill, 400–670 ft. above sea-level, in Hampshire; and the five acres of the Swanscombe Skull Site Geological Reserve in the disused Barnfield Gravel Pit in North Kent, which includes much unworked gravel available for research.

Woodwalton Fen has very rich fen flora, including an abundance of species which occur but sparingly

in East Anglian fen areas, such as the fen violet (*Viola stagnina* Kit.), the heath violet (*Viola canina* ssp. *montana* (L.)) and *Luzula pallescens* (Wahl) Bess, which are found in only one or two other localities in the British Isles. The Fen is equally rich in insect life. The Scolt Head Nature Reserve is one of the classic localities in the British Isles for the study of coastal erosion and sand- and shingle-bank formation and is scarcely less renowned for the variety and richness of its bird and plant life; it is one of the main terneries on the North Sea coast of Britain and a wintering area for shore larks and other rare birds. Havergate Island has become famous for the post-war establishment of a successful breeding colony of avocets; under protection, the Island has also acquired colonies of Sandwich terns and other interesting species and has become a very valuable feeding and resting station for many types of migrant birds. The agreement provides for the prohibition of shooting so that the Island may also be a sanctuary for wildfowl in the winter, and its invertebrate fauna includes many semi-marine spiders of a species new to science. Apart from the special interest of its bird and invertebrate fauna, the Orford beach shingle is of particular interest in regard to plant colonization.

The Old Winchester Hill Nature Reserve is situated mostly on the Middle Chalk; but its slopes present a great variety of aspects and, besides showing a wide variety of plants, well demonstrate the influence of rabbits on vegetation. Most of the Reserve is rough chalk grassland; but there are patches of well-grown yew and other chalk-loving trees, juniper, hawthorn and of common ling, while a strip of woodland at the bottom of the hill is spreading as ash seedlings invade the grassland.

In Scotland on March 9 the Nature Conservancy officially declared as a new Scottish nature reserve the area known as Tentsmuir Point, Fife. Before it became part of the Kingdom of Fife, Tentsmuir Point is believed to have been part of Southern Pictavia, the capital of which was at Abernethy. Fragments of pottery of the Bronze Age have been found on the Muir, and the pottery remains are both of the prehistoric iron type and the medieval jug type. The earliest settlers were hunters and fishermen who tended to be nomadic and can scarcely have affected its natural biological balance. The destruction of forests, largely to promote sheep-farming, assumed major proportions during the twelfth century, and among its far-reaching effects was to aggravate soil-blow. By about 1780 Tentsmuir was largely tilled, but even then it was the site of extensive lochs or shallow pools which were ultimately drained by ditching. Reclamation of the marshes also disturbed the biological balance, birds such as the bittern and the crane disappearing. Evidence was given to the Royal Commission on Coastal Erosion in 1911 that between 1853–55 and 1893–95, 534 acres of land were gained from the sea between St. Andrews and the Tay Estuary and 23 acres lost.

The area now declared consists of 92 acres purchased from the Forestry Commission and, besides dunes and intervening slacks reclaimed by natural processes from the sea, the new reserve includes a large extent of foreshore below the present high-water mark. The rapid gaining of ground from the sea affords an excellent site for the study of colonization, first by strand dune plants tolerant of saline conditions, followed by brackish water plants, and finally by the more usual plants of normal light soils. This varied flora includes several rare species and offers great scope for ecological studies, while the insect fauna and bird life are also of unusual interest. The establishment of the reserve fulfils an agreement of the Forestry Commission with the Dundee Naturalists' Society, when the latter relinquished claim to an area of eighty acres within the Tentsmuir Forest which had been set aside as a bird sanctuary. The Forestry Commission has also agreed not to plant an adjacent elongated dune slack within the Commission boundary and to make this available for study purposes.

THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON

REPORT FOR 1952

THE annual report for 1952 of the National Physical Laboratory, Teddington*, contains the report of the Executive Committee which was presented to the meeting of the general board on May 15 last, together with the more detailed reports, prepared by the respective superintendents, of the work of the various Divisions of the Laboratory.

The Executive Committee states that the main problem during the year under review was how to obtain maximum progress on the more important items of research with an inadequate staff. It is deplored that much effort had to be devoted to work for defence purposes and many short-term investigations undertaken at the cost of the traditional and fundamental tasks of the Laboratory.

Several changes are mentioned, including the transfer of the Radio Division of the Laboratory, first set up in 1933, to the Radio Research Organization and, in view of the close connexion between the work of the High Temperature Mechanical Properties Section and that of the Metallurgy Division in the high-temperature materials field, the incorporation of the Section in the Division until it can be transferred to the Mechanical Engineering Research Laboratory, East Kilbride, probably in five years time. Permission to proceed with the design of the new ship tank and cavitation tunnel to be built at Feltham was obtained, and considerable progress is reported with this work and on the construction of the building for the new High Speed Laboratory on the West Aero site to contain two new high-speed wind tunnels. The room in the aerodynamics building which contained the last remaining 4-ft. wind tunnel is to be used to house the DEUCE (digital electronic universal computing engine), the engineered version of the pilot model of the ACE (automatic computing engine), and when the new high-speed tunnels come into operation it is intended to convert the large building at present occupied by the duplex tunnel into a much-needed large lecture hall with accommodation for 350 people and into a canteen with adequate facilities for staff and visitors.

The annual open day[1] was held on May 23, 1952, and was attended by many scientific workers from the universities, government departments and industry, and a well-attended conference on the measurement and importance of the elastic properties of metals[2] took place during March 20–21. On April 22 the Laboratory was honoured by a visit from H.R.H. the Duke of Edinburgh, who spent the morning

* National Physical Laboratory: Report for the Year 1952. Pp. viii+72. (London: H.M.S.O., 1953.) 2*s.* 6*d.* net.

seeing a representative selection of the Laboratory's work.

The Laboratory again took part in the Physical Society's annual exhibition of scientific instruments and in one of the Royal Society soirées, and also sent exhibits to the International Machine Tool Trades Exhibition at Olympia and to the Fourth Industrial Physics Conference and Exhibition, Glasgow. During the year the proceedings of the 1951 symposium on "Present Developments and Techniques in the Maintenance of Standards" was published[3], and the series of "Test Pamphlets" and the short series on "Units and Standards of Measurement Employed at the Laboratory" were completed. In addition, Nos. 2 and 3 of the series "Notes on Applied Science", entitled "The Industrial Application of Aerodynamic Techniques" and "The Properties of Electrical Insulating Materials and Methods of Test", were issued. The complete list of publications is given in an appendix to the report. The director, Sir Edward Bullard, and many senior members of the staff paid numerous visits to countries overseas to attend conferences, visit laboratories or to obtain supplies of essential materials, and details of these visits are included in the report, together with the names of the members of the general board, executive committee and sub-committees, the positions and names of the senior staff, and bibliographies of the numerous scientific papers published by the director and members of the staff of the Divisions of the Laboratory.

The individual reports of the various sections of the Laboratory reveal that a wide range of interesting and important investigations have been undertaken. In the Light Division, several applications of the Merton integrating nut to precision linear measurement have been made, including the construction of a machine for producing linear scales of exceptional accuracy by repeated flash projection of the image of a slit upon a photographic plate advanced by the nut. Methods of colorimetry for the evaluation of the colours of fluorescent pigments and inks and 'fluorescent brightness' in detergents have been developed, and work on the properties of thin films has shown how to produce on glass transparent electrically conducting films of very low resistance. Remarkable results were obtained with gold films on a substrate of bismuth oxide. These films are pale straw in colour with a white-light transmission of at least 75 per cent and of electrical resistance as low as 6–7 ohms per 'square'. The Electricity Division has been mainly concerned with precision measurements of the dielectric constants of gases and liquids, and the Electronics Section with the development of digital computing equipment. One of the problems investigated by the Physics Division has been the reduction of noise from jet-engine test houses, and experiments have been made on the effectiveness of absorbent ducts as silencers. Research work and the results of trials conducted by the Ship Division have proved the importance of making hull-surfaces smooth and keeping them smooth, but the work has also shown that, even with the most carefully conducted trials, results fluctuate a great deal. This emphasizes the importance of detailed attention to every feature that can influence the performance of a ship.

In the report of the Metallurgy Division mention is made of the extension to the Division's laboratories to provide additional facilities for X-ray, electron diffraction and electron microscopy examination of metals and for radioactive tracer work. The effect of phosphorus on the embrittlement of iron at low temperatures has been studied, and a procedure established for the preparation of single crystals of iron. The investigation of the creep of metals and alloys has continued, and in collaboration with the Physics Division some very remarkable changes of the elastic properties in samples of chromium near room temperature have been examined.

[1] *Nature*, **170**, 527 (1952).
[2] *Nature*, **168**, 594 (1951).
[3] *Nature*, **172**, 335 (1953).

CALIFORNIA INSTITUTE OF TECHNOLOGY

ANNUAL REPORT FOR 1952–53

THE annual report of the California Institute of Technology for the year ending June 30, 1953, comprising the reports of the president of the Institute, Dr. L. A. DuBridge, and of the secretary and the comptroller and other administrative officers, together with reports of the different Divisions, are contained in the Bulletin of the Institute (**62**, No. 4; 1953)*. Dr. DuBridge notes that, of graduates accepting employment during the year, 78 per cent went into industry; but 53 per cent of those obtaining the bachelor's degree elected for postgraduate work. The student body is limited to about six hundred, of whom a hundred and eighty are freshmen, and the graduate body is fairly constant at four hundred, the faculty of the Institute numbering 334. Some 550 research papers were published during the year, and among research activities of the period, Dr. DuBridge selects for mention the study by the Seismology Laboratory of the series of earthquakes which were set off by the Arvin earthquake of July 21, 1952. This earthquake was followed by several hundred shocks of lesser magnitude during the year, and more was learned from this series than from all the previous recordings made during the twenty-five years of the Laboratory's existence. Prof. G. W. Housner and his colleagues obtained new data for their studies on earthquake-resistant structures. It was found that the seismic waves could be regarded as produced by a series of pulses, such as would result from a series of discrete slippages of a fault, and this theory will assist the analysis of the effects of strong earth motion on buildings and other structures.

In astronomy, Dr. Walter Baede's discovery that the groups of stars which had previously been used to establish the scale of astronomical distances are of two types, one substantially brighter than the other, indicates that distances had been under-estimated and that the most distant nebulæ visible on plates taken with the 200-in. Hale telescope at Palomar may be as much as two thousand million light-years away instead of one thousand million. New measurements in the Kellogg Laboratory indicate that the various isotopes of hydrogen and helium can account for all the sun's energy and that carbon is not involved at all in the combination of hydrogen into helium.

Geochemical research came into full swing during the year, but the air-conditioning equipment of the

* California Institute of Technology: Annual Reports 1952–53. Comprising the Reports of the President, the Secretary, the Comptroller, and Other Administrative Officers. Pp. v+42. (Pasadena, Calif.: California Institute of Technology, 1953.)

laboratories had to be supplemented with special filters to keep the laboratory free from lead (from lead tetraethyl in anti-knock petrol). The Gladwin tree-ring measurements of traces of helium in rocks, combined with the isotopic ratio of carbon-12 to carbon-13, and radioactive carbon-14, now give ages from twenty thousand years upwards, while the lead–uranium ratio can be used to date geological samples at the upper end of the scale to four billion years.

In the Division of Physics the operation of the new synchrotron has steadily improved, and a large and reliable electron beam is always available. The X-rays produced have been used for studying the creation of mesons in hydrogen, a process which proved to be more complex than had been predicted. In the new cosmic-ray laboratory Prof. C. Anderson and his colleagues have found that a charged particle which is heavier than a proton decays into a proton plus a neutral meson. There are also neutral V-mesons which decay into two π-mesons, and τ-mesons which decay into three π-mesons. Two research units are devoted to problems in jet propulsion, one of which, the Guggenheim Jet Propulsion Centre on the campus of the Institute, is devoted to basic theoretical and experimental studies and to the training of students. The Jet Propulsion Laboratory, five miles from the campus, is financed principally by a contract with the Ordnance Corps of the United States Army; although concerned partly with the development of guided missiles, it also carries out much fundamental research on fuels, thermodynamics, cooling and combustion, electronic guidance and control, and related subjects.

In the Division of Chemistry and Chemical Engineering further progress has been made in the study of various types of hæmoglobin in blood, especially types that cause diseases of the anæmia type. A promising substitute for blood plasma, oxypolygelatine, has been brought to the point of extensive clinical trials. Further light has been shed on the reactions catalysed by the proteolytic enzyme, alpha-chymotrypsin, obtained from bovine pancreas, on the nature of the substance produced by *E. coli* which has the power of causing hæmorrhage in tumours, and of the chemical nature of febrifugine, an antimalarial obtained from a Chinese drug. Studies have been made on coulometric titration, a new method of analysis in which the amount of chemical reaction is measured by determining the amount of electricity used to produce one of the substances participating in the reaction.

A new theory of ferromagnetism has been developed which permits the use of spectroscopic data in predicting the magnetic properties of substances, an electron diffraction technique has been used to determine the molecular structure of volatile boron compounds, ozone, oxygen fluoride and other compounds, and further progress is reported in the application of the phase-shift theory to interpret experimental electron-diffraction data. Additional structural information on amino-acids, simple peptides and other substances related to proteins was obtained during the year, and several synthetic polypeptides proved to possess the configuration of the alpha-helix, a mode of folding the polypeptide chain in which there are 3·6 amino-acid residues per turn of the helix. X-ray photographs indicate that collagen may have a helical structure, with ten units of these amino-acid residues each in three turns or seven turns of the helix, and X-ray photographs of nucleic acids were likewise interpreted to indicate the presence of a nucleic acid molecule consisting of three helical polynucleotide chains arranged about a common axis. The Chemical Engineering Laboratory continued its work on turbulent flow and on the diffusion of the lighter hydrocarbons in the liquid and gas phases under the conditions encountered in petroleum reservoirs, as well as on the thermodynamic equilibrium of petroleum constituents at the high pressures and temperatures found in deep oil reservoirs.

In the Division of Biology the plaque method of growing animal viruses on monolayer tissue cultures was extended to poliomyelitis virus. Studies on the biosynthesis of proteins included studies on substances that stimulate the formation of red blood cells with consequent increase in total hæmoglobin, the use of cell-free preparations of bacterial cells disrupted by the enzyme lysozyme in the enzymatic incorporation of amino-acids into proteins, lysine metabolism, and the role of polypeptides as intermediates in protein synthesis. Work continued on the electrical disturbances induced in the cortex of animals following various types of electrical stimulation, and the functional activities of the central nervous system of the freshwater crayfish were further mapped. Additional studies were made of the chemical composition and method of action of fertilizin and antifertilizin substances which are important in the fertilization of certain marine animals. Investigations were continued on chromosome aberrations and gene mutations induced in maize by X-rays, gamma-rays and atom-bomb radiations, and the gene concerned with the white-eye character in *Drosophila* was studied in an attempt to discover more about the mechanism responsible for this type of position effect. *Neurospora* enzymes known to be gene-controlled or likely to be useful in genetic studies have been investigated, as well as three closely related genes in the mould *Aspergillus* concerned with the synthesis of biotin, while many aspects of plant growth, flowering and fruiting have been studied. It has been shown that, under appropriate conditions of light, temperature, air movement, mineral nutrition, etc., tomatoes may yield as much as 160 tons per acre. Factors affecting the growth and production of sugar in the sugar beet were being studied, as well as the growth characteristics and climatic responses of varieties of pea, and the hormonal control of growth, flowering, fruiting and other responses of the higher plants; investigations initiated by Mr. S. Duvdevani, of the Dew Research Station of Israel, as research Fellow of the Institute in 1952, have already shown that many plants can take in water through their leaves and excrete it in liquid form through their roots, thus pointing to the critical importance of a few drops of water for survival under extreme conditions of drought.

FILM-STRIPS OF NORTH AMERICAN NATURAL HISTORY

THE use of films as a teaching aid began about a generation ago, and since that time the fortunes of educational film-makers have fluctuated a great deal. While some teachers have been wildly enthusiastic about the value of films in teaching, others have quite genuinely felt that it was an expensive luxury which, while pleasant to use, could never be more than a frill to be used occasionally as

a change from the essential chalk and talk. With the advent of talking films the enthusiasts felt that the new era of visual aids had arrived. Others, more sober, continued to use the silent film as the more useful adjunct to direct teaching.

Above the noise of controversy remained the still, small voice which eventually compelled most hearing, the matter of finance. Whether sound or silent, films are expensive to produce and, for teachers working on modest budgets, often too expensive to hire. Many teachers wished to make regular use of talking or silent films, but the means were beyond them.

It was into this atmosphere, mainly during the Second World War, that film-strips began to appear. Among their merits are low cost, the light compactness of the projector used in showing them, and the fact that the teacher could vary his teaching to deal with those parts of the film-strip in which his class was interested at any given time. The rise in their use has been rapid. Thousands were made for different purposes in the Armed Forces, while impecunious teachers have been able to buy or borrow them at low cost or even make their own.

It is not unexpected that, as with educational films, among the most popular film-strips have been those dealing with biological subjects. Yet these topics have been mainly 'laboratory' ones, and there are surprisingly few film-strips dealing with natural history as such. One must be grateful, therefore, to Unicorn Head Visual Aids, Ltd. (Broadway Chambers, 40 Broadway, Westminster, London, S.W.1, price 12*s*. 6*d*. each) for its enterprise in sponsoring four film-strips made by the National Film Board of Canada, as follows: the beaver (*C*.79); little brown bat (*C*.80); North American moose (*C*.81); and Barren Ground caribou (*C*.83). The one dealing with the North American moose includes a fine set of lectures illustrating the natural environment in which this mammal lives, its distribution, feeding and breeding habits, its predatory rivals and the use of the moose to man; the strip is supplemented by a valuable script which includes accounts of the moose in legend and folk-lore.

Another strip, on the Barren Ground caribou, although not treated so imaginatively as that on the moose, covers the same range of topics with perhaps more emphasis on its relationship to man; the script describes how to preserve the caribou. Authorities are trying to teach people in the north to feed their dogs on fish, saving the caribou for human use.

The strip on the North American beaver contains a number of frames showing how the animal builds dams and lodges; its interest is heightened by imaginative treatment.

Equally interesting is the strip describing the natural history of the most common bat in Canada, the little brown bat; the accompanying script is well written with, *inter alia*, accounts of its eating, drinking and sleeping habits, the method of getting rid of unwelcome bats from domestic properties, and the superstitions about the bat which die so hard.

These four strips would have been popular with the late Sir D'Arcy Thompson, who was constantly urging that biology teachers in schools should not neglect the life-histories of the larger animals of the earth while dwelling on the insides of the smaller. Up-to-date strips of the kind reviewed might be much more popular with children than the re-hashed films of ancient vintage which serve so often as 'entertainment' at children's parties to-day.

T. H. Hawkins

REACTIONS OF METHÆMOGLOBIN AND CATALASE WITH PEROXIDES AND HYDROGEN DONORS

By Prof. D. KEILIN, F.R.S., and Dr. E. F. HARTREE
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STUDY of the reactions of methæmoglobin with different substances was found to be of great help in understanding the mechanism of similar reactions given by other hæmoproteins. We shall examine here the results of some experiments with methæmoglobin and catalase which have a direct bearing upon the much discussed problem of the mechanism of the catalatic decomposition of hydrogen peroxide to molecular oxygen and water.

Reaction of the Methæmoglobin-Peroxide Compound with Different Donors

Methæmoglobin was obtained from thrice recrystallized horse hæmoglobin which was oxidized either with potassium ferricyanide or with sodium nitrite and exhaustively dialysed against water.

As some of the reactions which will be described here rapidly pass through several stages yielding unstable products, the sequence of reactions has been followed and the unstable intermediates recognized, by changes in the absorption spectra in the visible region observed by means of a low-dispersion microspectroscope.

The reactions of acid methæmoglobin at *p*H 6·0–7·3 with different substances can be summarized as follows.

(1) Acid methæmoglobin, which is brown in colour and shows a characteristic absorption band at 630 mμ, reacts with hydrogen peroxide forming a red methæmoglobin-peroxide compound[1,2] with two absorption bands: an asymmetric α-band at 589 mμ and a stronger β-band at 545 mμ. A similar compound is given with ethyl hydroperoxide[1]. The reaction between metmyoglobin and hydrogen peroxide was recently reinvestigated by George and Irvine[3,4], who found by spectrophotometric titration with ferrocyanide that metmyoglobin-peroxide is only one oxidizing equivalent higher than metmyoglobin itself. They concluded that the compound is not a reversibly formed metmyoglobin-hydrogen peroxide complex but is the product of an irreversible reaction. Moreover, they obtained metmyoglobin-peroxide not only with hydrogen peroxide and methyl hydroperoxide but also with other oxidizing agents such as sodium chlorite, potassium chloriridate and potassium molybdicyanide. Metmyoglobin-peroxide reacts, according to them, as an iron derivative with an effective oxidation number of + 4.

(2) When an excess of hydrogen peroxide is added to methæmoglobin, the peroxide undergoes catalatic decomposition to oxygen and water, while the methæmoglobin becomes reduced to hæmoglobin, which is rapidly oxygenated to oxyhæmoglobin by oxygen generated in the immediate vicinity of the iron atom[5]. This high effective concentration of oxygen explains the very slow formation of carbon monoxide hæmoglobin even when the solution is kept saturated with carbon monoxide. The catalatic decomposition of hydrogen peroxide, as we shall see later, can be described as a peroxidatic oxidation of hydrogen peroxide by methæmoglobin-peroxide,

hydrogen peroxide in this reaction acting both as substrate and as hydrogen donor.

(3) Methæmoglobin-peroxide also reacts with other hydrogen donors, such as hydroquinone, pyrogallol and catechol which undergo peroxidatic oxidation, while methæmoglobin becomes reduced to hæmoglobin, which is immediately oxygenated to oxyhæmoglobin and in presence of carbon monoxide gradually forms carbon monoxide hæmoglobin. Thus, if to methæmoglobin solution at *p*H 6 containing one of the above polyphenols is added a little hydrogen peroxide, methæmoglobin turns almost at once to oxyhæmoglobin, before the solution darkens owing to oxidation of the polyphenol.

(4) Methæmoglobin combines reversibly with azide, giving a very stable compound which is red in colour and shows two absorption bands at 575 and 543 mμ. The formation of this compound requires one molecule of azide per iron atom of methæmoglobin[6]. Magnetic measurements of this compound indicate that the iron atom is linked with the surrounding atoms by essentially covalent bonds[7].

(5) Methæmoglobin-azide does not easily react with hydrogen peroxide, which, when added in excess, gradually destroys the hæmatin nucleus.

(6) Methæmoglobin-peroxide, on the contrary, reacts very rapidly with azide, which undergoes peroxidatic oxidation. As we shall show, one of the products of oxidation of azide is nitric oxide, which is known to combine both with hæmoglobin and methæmoglobin. In order to follow this reaction one must be prepared to recognize the absorption spectra of five possible derivatives of methæmoglobin. They are: methæmoglobin-peroxide, methæmoglobin-azide, methæmoglobin-nitric oxide, hæmoglobin-nitric oxide and oxyhæmoglobin. Although the absorption spectra of these derivatives are of the same general pattern, they can nevertheless be differentiated. Careful spectroscopic study of this peroxidatic reaction reveals the initial formation of oxyhæmoglobin and hæmoglobin-nitric oxide, which is followed by rapid destruction of the hæm nucleus. If the methæmoglobin solution is previously saturated with carbon monoxide, the appearance of oxyhæmoglobin is followed by the formation of carbon monoxide hæmoglobin and the ultimate destruction of the hæm nucleus. These experiments show that peroxidatic oxidation of azide by methæmoglobin-peroxide is accompanied by valency changes of the iron.

Similar reactions are obtained with some other hydrogen donors provided that neither the donor itself nor its oxidation products, which are formed in the vicinity of the iron atom, reoxidize the divalent iron of hæmoglobin rapidly enough to prevent its oxygenation.

Although oxyhæmoglobin (or carbon monoxide hæmoglobin) is the initial visible product in some of the peroxidatic reactions catalysed by methæmoglobin, further oxidation is prone to occur in which the hæmatin nuclei are degraded. The degradation of hæm is very rapid, especially when azide or hydroxylamine serve as hydrogen donors.

Reactions of Catalase with Azide and Hydrogen Peroxide

(1) Catalase combines with azide, forming catalase-azide[9], which resembles free catalase in colour, the pattern of absorption spectrum, the non-reducibility of its iron and in its high paramagnetism, which indicates ionic bonding of the iron atom[10].

(2) When hydrogen peroxide is added to catalase, its rapid, almost explosive, decomposition to oxygen and water is not accompanied by any marked changes in the colour and absorption spectrum of the enzyme that can be observed in the usual way, as in the case of methæmoglobin and peroxidase. However, under special experimental conditions, it is possible to demonstrate that catalase, like peroxidase, forms with peroxides three distinct compounds (I, II and III). The structures of these compounds and their relationships lie outside the scope of this article. All we can say here is that methæmoglobin forms with peroxide only one such compound which spectroscopically corresponds to compound III of peroxidase or catalase.

(3) When hydrogen peroxide is added to catalase-azide, the colour of the solution turns from greenish-brown to red and the methæmoglobin-like absorption spectrum is replaced by two bands in the visible region at 587 and 554 mμ. That the iron of this derivative of catalase is in the divalent state is clearly shown by the following properties[9,11]: (*a*) the compound is autoxidizable, being "stable only in absence of O_2; in its presence it rapidly reoxidizes to the original azide-catalase"[11]; (*b*) like other ferrous hæmatin compounds, it reacts with carbon monoxide, forming a well-defined compound which is more stable in air, and which has absorption bands at 580 and 545 mμ; (*c*) the residual catalatic activity of catalase-azide is strongly and reversibly inhibited by carbon monoxide; (*d*) cyanide, which can easily replace azide in catalase-azide, has no effect on the derivative arising by treatment of catalase-azide with peroxides.

Reaction of Catalase-Azide with Hydrogen Peroxide

Since the ferrous derivative obtained when catalase-azide is treated with hydrogen peroxide reverts on oxidation to ferric catalase-azide, we postulated that this derivative is ferrous catalase-azide. This view has not been generally accepted. Thus, Foulkes and Lemberg[13] suggested that the compound is probably ferrocatalase-nitric oxide, the nitric oxide being derived from oxidation of azide. The evidence in favour of this view is that while nitric oxide has no effect on the compound, it reacts with its carbon monoxide derivative to give the original absorption spectrum of "ferrocatalase-azide". Moreover, it was previously shown[1,9] that catalase-hydroxylamine reacts with hydrogen peroxide to give a ferrocatalase derivative indistinguishable from that obtained with azide, and hydroxylamine can also be expected to give nitric oxide on oxidation. However, Foulkes and Lemberg failed to detect in these reactions either the disappearance of azide or the formation of nitric oxide.

The reaction between catalase, azide and hydrogen peroxide was recently re-investigated by Theorell and Ehrenberg[14], who found that in this reaction azide undergoes peroxidatic oxidation to nitrous oxide and nitrogen, and that this reaction is accompanied by cyclic valency changes of catalase iron. They suggested that the ferrous derivative thus obtained is either the azide or the nitrous oxide derivatives of ferrocatalase. Thus, much uncertainty still remains as to the true nature of this compound. The problem could be solved by studying the reactions of free ferrocatalase with azide, nitrous oxide and nitric oxide. Unfortunately, free ferrocatalase cannot be obtained, since the trivalent iron of native ferricatalase cannot be reduced even by such a powerful reducing agent as sodium dithionite.

The problem can, however, be investigated by using freeze-dried ('lyophilized') catalase. Dounce and Howland, who first described such material[15], have shown that although it still retains the fundamental properties of an untreated catalase, it differs from the original material in several respects; in particular, it can be reduced with dithionite. Since the activity (Kat. *f*) of their catalase preparation dropped from 35,000 to 11,000, that is, to less than a third, after this treatment, we expressed some doubt as to the correctness of their interpretation and suggested the possibility that their preparation was a mixture of unmodified, fully active catalase and modified, reducible, inactive catalase[11]. The subject was, however, re-investigated by Dounce and Schwalenberg[16], who obtained strong evidence in support of their claims. Following the description given by these workers, we have since been able to corroborate their results. The chief interest of this catalase preparation is that it can be reduced by dithionite to give a ferrocatalase with an absorption spectrum of the same pattern as that of ferroperoxidase. We have shown that ferrocatalase thus obtained combines neither with azide nor with nitrous oxide. It does, however, combine with nitric oxide and with carbon monoxide, forming compounds spectroscopically indistinguishable from catalase-azide treated with hydrogen peroxide in the absence and in the presence of carbon monoxide respectively. We must therefore assume that when catalase-azide is treated with hydrogen peroxide, the first step of the reaction consists in replacement of azide by peroxide to give catalase-peroxide. The latter reacts peroxidatically with azide to give nitrous oxide and nitrogen as the main products, together with a little nitric oxide, while catalase is reduced and stabilized as ferrocatalase-nitric oxide.

That nitric oxide at a low concentration appears as one of the products of interaction of catalase-azide and hydrogen peroxide was shown experimentally as follows. Mixtures of catalase and sodium azide in phosphate buffer, *p*H 5–6, were treated dropwise with very dilute hydrogen peroxide, while a stream of air was drawn through the mixture and eventually through a trap cooled in liquid air. Treatment of the trap contents with Griess reagent gave a positive indication of nitrous acid. Negative results were, however, obtained if either catalase or peroxide were omitted from the reaction mixture. Nitrite production was also detected if azide was added to the glucose oxidase (notatin) system and catalase under the conditions previously described for the coupled oxidation of ethanol[17].

The amount of nitric oxide formed during the reaction of catalase-azide with peroxide is certainly very small, but since it is generated in close proximity to the divalent iron for which it has great affinity, ferrocatalase-nitric oxide will readily be formed. The only point which remains to be clarified is that the magnetic properties of this compound, as recorded by Theorell and Ehrenberg[13], fail to reveal the presence of the one unpaired electron that such a compound should possess[18]. They found that the compounds obtained either in nitrogen or in carbon monoxide have zero magnetic moment. While their data on the stable carbon monoxide derivative appear to be reliable, a degree of uncertainty is inevitable in measurements on the less stable derivative obtained in nitrogen. The possibility of one unpaired electron in this derivative cannot, therefore, be entirely excluded.

Mechanism of Catalatic Decomposition of Hydrogen Peroxide

Considering that the combination of ferricatalase with azide is perfectly reversible and that catalase-azide has many properties in common with free catalase, the reaction of catalase-azide with hydrogen peroxide was taken by us as a suitable model for study of the mechanism of the decomposition of hydrogen peroxide by free catalase. We therefore postulated that the catalytic activity of free catalase, like that of catalase-azide, is accompanied by valency changes of the iron, which is reduced by peroxide molecules undergoing catalatic decomposition and reoxidized by oxygen. The inhibition of the catalatic reaction by azide was ascribed by us to stabilization of ferrocatalase, that is, to a slowing down of its reoxidation. Our theory that catalatic decomposition of hydrogen peroxide involves cyclic reduction and oxidation of catalase iron has been repeatedly discussed in the literature and several objections have been raised against it. We shall now examine these objections in the light of our more recent experimental results.

The reoxidation of ferrocatalase by oxygen should result, according to some workers, in the production of hydrogen peroxide, which would thus reappear in the second step of the reaction as fast as it disappears in the first step. Such a view implies that the oxidation of autoxidizable hæmoproteins invariably results in the reduction of oxygen to hydrogen peroxide. Such an assumption is, however, unjustified. Thus no hydrogen peroxide can be detected during the catalytic activity of cytochrome oxidase, even when the activity of residual catalase is completely abolished by hydroxylamine.

Since, according to our theory, oxygen is an essential component of a system involved in the catalatic decomposition of hydrogen peroxide, the removal of oxygen should inhibit the reaction. In fact, at one time we believed it possible to demonstrate this effect[19]. However, this was not confirmed by other workers[10,20,21] and we later discovered[22] that the inhibition of catalatic activity, which we invariably obtained in experiments where the gas phase was oxygen-free nitrogen, was due not to the absence of oxygen but to the presence of a minute amount of nitric oxide formed by passing cylinder nitrogen over copper at a temperature well above the optimum of 400° C. On the other hand, failure to inhibit the catalatic reaction by replacing oxygen with pure nitrogen or carbon monoxide does not materially weaken the theory that oxygen does take an active part in the reaction. Since oxygen resulting from the catalatic decomposition of hydrogen peroxide is generated in the immediate vicinity of the iron atom, the effective oxygen tension at this point will be high regardless of the fact that oxygen-free conditions have been established in the medium as a whole. Thus, immediate reoxidation of any autoxidizable ferrous form of catalase must invariably occur. The importance of localization of liberated oxygen at the catalytic centre was also shown in the experiment cited above on the reactions of methæmoglobin-peroxide with different hydrogen donors.

Having shown that azide underwent oxidation in presence of catalase and hydrogen peroxide, Theorell and Ehrenberg[14] concluded: "Since azide is shown to act as a donor and not merely as an inhibitor, the reduction of catalase iron in the presence of hydrogen peroxide and azide cannot be taken as a support for

Keilin and Hartree's theory of a ferric–ferrous cycle being involved in the decomposition by catalase of hydrogen peroxide". Although their experiments clearly show that, in the reaction of catalase with azide and hydrogen peroxide, azide does act as a hydrogen donor, they do not, in our opinion, affect the validity of our views. On the contrary, they reveal that the mechanism of catalatic decomposition of hydrogen peroxide resembles much more closely that of the reaction between catalase peroxide and azide than was anticipated by our theory. Indeed, their results, together with our experiments, on methæmoglobin summarized above, offer additional evidence in support of the view that cyclic valency changes of iron are involved in the activity of catalase. This evidence can be summarized as follows.

(1) Following the discovery that catalase can use hydrogen peroxide for the peroxidatic oxidation of alcohols[17,23], the concept of the peroxidatic function of catalase was extended to the oxidation of other donors such as nitrite[24], formaldehyde, formic acid and hydrogen peroxide itself[25,26], the latter acting both as substrate and as hydrogen donor. The catalatic decomposition of hydrogen peroxide can therefore be described as a peroxidatic reaction, wherein one molecule of hydrogen peroxide is oxidized by another. To the list of donors we can now add azide[12] and hydroxylamine. It is only with the last two donors, which on peroxidatic oxidation generate, among other products, some nitric oxide, that the reduction of catalase iron can be easily observed.

(2) Methæmoglobin also oxidizes peroxidatically a variety of hydrogen donors such as hydroquinone, pyrogallol, catechol, azide and hydrogen peroxide, the latter undergoing catalatic decomposition to oxygen and water. All these reactions are accompanied by valency changes of iron.

(3) On comparing the peroxidatic activities of catalase and methæmoglobin, especially when the donor is hydrogen peroxide itself, it is not surprising that reduction of the iron cannot be recorded in catalase, while it can so readily be observed in methæmoglobin. In fact, the iron-catalysed reaction provides a localized high concentration of oxygen which will reoxidize the iron of ferrocatalase as fast as it appears and so promote the overall reaction, whereas it will oxygenate the non-autoxidizable iron of hæmoglobin, stabilize it as oxyhæmoglobin and thus inhibit the reaction. The chances of observing the divalent state in a peroxidatic reaction promoted by a hæmoprotein therefore depend upon the appearance in the vicinity of the catalytic centre of a substance capable of combining with, and so stabilizing, the ferrous form.

Of the few substances which are so far known to combine with the divalent iron of hæmoproteins, only oxygen and nitric oxide can be generated by peroxidatic reactions. While oxygen can stabilize hæmoglobin and inhibit its reoxidation to methæmoglobin, nitric oxide can stabilize both hæmoglobin and ferrocatalase. The reduction of catalase iron is thus readily observed when azide or hydroxylamine, but not hydrogen peroxide, act as donors in a peroxidatic reaction catalysed by this enzyme.

It can be said in conclusion that the available experimental results support the view that the peroxidatic activities of methæmoglobin and catalase with respect to certain donors, including hydrogen peroxide, which undergoes catalatic decomposition to oxygen and water, involve the intermediate formation of ferrous forms of these hæmoproteins.

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BLOOD COAGULATION: EVIDENCE OF AN ANTAGONIST TO FACTOR VI IN PLATELET-RICH HUMAN PLASMA

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WHEN Owren[1] discovered a patient with a hæmorrhagic diathesis due to deficiency of a previously unknown factor necessary for normal blood coagulation, he first called the new clotting component the fifth coagulation factor or factor V, but later preferred the term pro-accelerin[2]. Independently, Quick[3] produced experimental evidence showing that his one-stage prothrombin time was dependent on the presence of two plasma components —a storage-labile fraction which he termed prothrombin component *A* and a stable fraction which he named prothrombin component *B*. Later, he chose to refer to component *A* as labile factor[4]. Fantl and Nance[5] also independently published evidence of the existence of a factor which accelerates the conversion of prothrombin to thrombin, and Ware *et al.*[6] announced the discovery of a globulin substance with similar accelerator activity, referring to it as plasma accelerator globulin (ac-globulin). Further, Honorato[7] published experiments with what he called a plasmatic co-factor of thromboplastin. That all these workers were dealing with the same substance is now generally accepted[10]. In addition, other lesser-known names have been given to it. Many of its physico-chemical properties are known[8]. Owren[1] soon recognized that the factor as it exists in plasma is in the precursor state, and that it becomes activated during coagulation to what he first called factor VI, but later

accelerin[2]. In this he was supported by the observations of Ware *et al.*[9], who spoke of the activated form as serum ac-globulin. This concept is now accepted by most workers[10]. For the purpose of this communication, Owren's original nomenclature of factors V and VI is preferred.

In oxalated human plasma, factor V is storage-labile and human factor VI is even more labile than its precursor, but it is stable in bovine and rabbit serum[11,12]. Further, Owren[1] observed that factor VI disappears more rapidly when plasma is present. These observations have caused speculation on the possible existence of a specific enzyme responsible for destroying factor VI[8].

While experimenting with oxalated plasmas of patients suffering from congenital factor V deficiency, evidence was found of the existence of such a factor VI antagonist. These patients have no abnormality of their other coagulation factors. Their one-stage prothrombin time[13] is usually in the region of 40 sec. (normal control, 11–12 sec.). To obtain normal serum, normal human blood in 3 c.c. amounts was allowed to clot at room temperature (22–25° C.); 60 min. after coagulation the serum was separated and oxalated by addition of 1 volume of 0·1 *M* sodium oxalate solution to 9 volumes serum. After standing for a further 13 min., it was briefly centrifuged to remove precipitated calcium oxalate. It was used in the experiments exactly 75 min. after clotting. Adsorption of such serum with 0·008 *M* tricalcium phosphate made no material difference to the results reported here. The plasma used in these experiments was, however, rich in platelets. It is therefore not possible to say at this stage whether the anti-factor VI activity resides in the plasma or blood platelets.

When the prothrombin time of these patients' plasma is reduced by the addition of factor V in the form of plasma from a normal donor, the prothrombin time of the mixture remains virtually unchanged if left at room temperature for an hour; but a similar reduction of their plasma prothrombin time, by the addition of factor VI in the form of fresh oxalated serum from a normal donor, results in a mixture with a prothrombin time which deteriorates on standing. This indicates that the plasma of these patients is capable of inactivating factor VI, but has little or no effect on factor V as measured over a short period. The rate of destruction of factor VI varies considerably from time to time in the plasma of the same patient. This is well illustrated by the two curves in Fig. 1. They were recorded on the same patient's plasma, one a week after the other. In each case, one volume of fresh oxalated serum from a normal donor

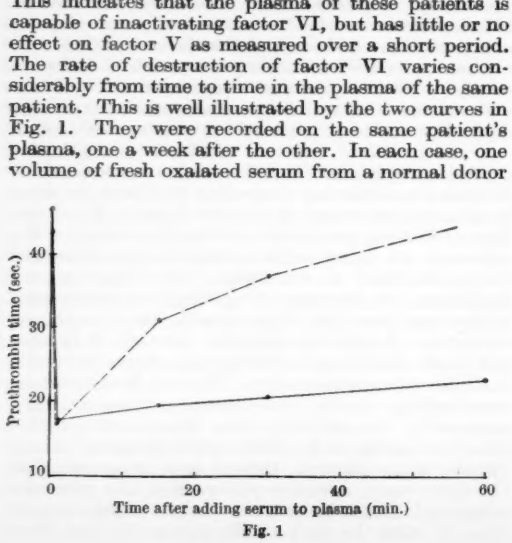

Fig. 1

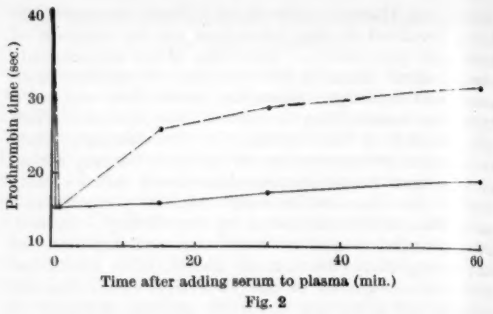

Fig. 2

was added to nine volumes of patient's plasma and left at room temperature (22–25° C.).

Since factor VI is known to be labile on storage, the question arises as to whether its loss is due to destruction on the part of the plasma or whether it can be ascribed merely to passive disappearance. However, it was repeatedly observed that factor VI is lost more rapidly from such plasma–serum mixtures than from the native oxalated serum, indicating active destruction by the plasma. Furthermore, when identical portions of the same serum are added to the plasmas of two different patients, the enhancement produced in their prothrombin times deteriorates at different rates in parallel experiments under identical conditions, thus ruling out the possibility of mere passive loss of factor VI and clearly indicating more active destruction on the part of one plasma than the other. This is illustrated by the two curves in Fig. 2. 10 per cent additions of the same serum were made to the plasmas of two different patients in a parallel experiment.

It was considered possible that destruction of factor VI was a function peculiar to the plasmas of these patients. However, a similar activity was demonstrated in aged normal oxalated plasma, and, by utilizing plasma and serum from patients receiving dicoumarol, it was possible to show that an individual's plasma will destroy his own factor VI. It may also be mentioned that factor VII [14] does not influence the prothrombin time of these patients; and their own fresh sera, although rich in factor VII and residual prothrombin, but naturally lacking in factor VI, do not influence prothrombin time when added to their plasmas. It has not yet been possible to ascertain whether the 'stable' factor VI of certain lower animals will be destroyed by this factor VI antagonist.

Details of this work are contained in my thesis for a doctorate, presented at the University of Pretoria, South Africa. [Nov. 26.

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LETTERS TO THE EDITORS

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Influence of the Nucleus on Anaerobic Breakdown of Adenosine Triphosphate

We have shown earlier[1] that non-nucleated fragments of *Amoeba proteus* maintain a normal oxygen consumption for as long as ten days; since the removal of the nucleus quickly reduces the uptake of phosphorus-32 by the cytoplasm[2], we concluded that the nucleus plays a part in the coupling between oxidations and phosphorylations, possibly by the production of some co-enzyme. Later experiments[3] showed, however, that such a simple hypothesis can scarcely be correct, since the adenosine triphosphate content of nucleated and non-nucleated halves remains almost identical for a considerable length of time (twelve days).

The recent publication by Strehler and Totter[4] of a sensitive and quick method for the estimation of adenosine triphosphate (based on the luminescence of fireflies extracts in the presence of that substance), and the description by Benesch and Benesch[5] of a simple technique for maintaining anaerobic conditions, led us to study the adenosine triphosphate content of nucleated and non-nucleated halves of *A. proteus*, both in aerobiosis and in anaerobiosis. The method of Benesch and Benesch[5] is based on the removal of oxygen from solutions by the glucose–glucoseoxidase–catalase system; control experiments have shown that neither these enzymes nor glucose—when taken separately—exert any measurable effect on the adenosine triphosphate level in the amoebae. When amoebae are placed in the medium of Benesch and Benesch[5], they behave exactly as when they are subjected to usual anaerobic conditions[6].

The results obtained after a period of 16 hr. anaerobiosis are given in Table 1; in each experiment, two hundred fragments were finally suspended in 75 μl. of Chalkley's medium and placed in a boiling water-bath for 2–3 min. in order to extract the adenosine triphosphate; the estimations of the adenosine triphosphate content, which were kindly performed by Dr. M. Errera, were made in duplicate on 30-μl. samples. The results in Table 1 are expressed in γ ATP/200 fragments/ml.

Table 1

Days after sectioning	Type of fragments	No. of expts.	ATP in aerobiosis	ATP in anaerobiosis	ATP lost in anaerobiosis (per cent)
0–1	Nucleated	6	0·057	0·047	17·5
0–1	Non-nucleated	6	0·058	0·018	69
4–9	Nucleated	5	0·065	0·033	50
4–9	Non-nucleated	5	0·062	0·019	70

These results confirm that the adenosine triphosphate content of nucleated and non-nucleated halves of amoebae remains the same in the presence of air; but a very striking difference occurs in anaerobiosis: the nucleated fragments then retain a much larger proportion of their adenosine triphosphate in the phosphorylated condition than the non-nucleated halves; this is especially true for a short time after the amoebae have been cut, that is, when they still have a large store of carbohydrate reserve.

It is likely that the maintenance of a high level of adenosine triphosphate in anaerobiosis is linked to glycogenolysis; previous work[7] has shown that glycogen utilization by nucleated halves is faster during the first three days than later; the non-nucleated fragments are only capable of a very limited utilization of their carbohydrate reserve. Preliminary cytochemical observations on the glycogen content of both types of fragments in anaerobic conditions have clearly shown that nucleated halves from well-fed amoebae (0–1 day after sectioning) lose a very large proportion of their glycogen during a 16-hr. anaerobiosis period; such striking staining changes never occur in the case of non-nucleated fragments or of four-day old nucleated halves. Apparently, removal of the nucleus quickly and simultaneously impairs both glycogen breakdown and ability to keep adenosine triphosphate in the phosphorylated state in anaerobic conditions.

The conclusion that the nucleus controls certain steps of the glycolytic mechanism would be in agreement with Stern and Mirsky's[8] finding that wheat-germ nuclei are richer than the cytoplasm in various glycolytic enzymes; however, it was found (Table 2) that at any rate enolase, which according to Stern and Mirsky[8] is definitely accumulated in these nuclei, is almost equally distributed between nucleated and non-nucleated halves of amoebae.

Table 2. Enolase Activity in 10^{-3} μM Phosphoglyceric Acid/100 Fragments/5 hr. at 36°

Days after sectioning	Nucleated halves	Non-nucleated halves
2	5·3	4·4
3	3·9*	3·1*
6	6·7	6·3
7	7·3	6·3
11	4·2	3·6

* Experiment performed at 30°.

This negative finding leads us to believe that the nucleus probably plays a part in the activation of glycolytic enzymes (by production of co-factors) rather than in their actual synthesis. Further work will be required to elucidate at which step the nucleus is acting; both the phosphorylating systems and the steps involving diphosphopyridine nucleotide (DPN) are possibilities, since there have been reports that diphosphopyridine nucleotide is synthesized and accumulated in the nucleus[8–9].

Finally, it is worth pointing out that decreased capacity for keeping adenosine triphosphate in the phosphorylated form during anaerobiosis and reduced glycogen utilization probably are characteristic biochemical abnormalities whenever the nucleus is severely damaged, since similar metabolic difficulties have been found in strongly lethal interspecific frog hybrids[10].

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Chlorophyll and Photosynthesis in Stomatal Guard Cells

Investigations in this laboratory carried out by different techniques from those of Shaw and MacLachlan give direct support to their recent statements[1] with regard to the presence of chlorophyll in stomatal guard cells and the ability of these cells to assimilate carbon dioxide by photosynthesis. Measurements of light absorption made on intact plastids in the living guard cells of leaves of *Rumex patientia*, *Chrysanthemum maximum* and *Vicia faba* have shown the presence of chlorophylls *a* and *b*. Moreover, an active synthesis of carbohydrates in the light is clearly indicated by the diurnal changes of sugars and starch in the epidermis of the leaf.

The absorption spectrum of individual plastids in the guard cells was determined by means of a microspectrophotometer developed by Dr. W. K. Metcalf and Mr. K. W. Keohane. Measurements made on *Rumex patientia* are shown in Fig. 1. The absorption at the red end of the spectrum corresponds closely with that expected for a mixture of chlorophylls *a* and *b*. A well-marked maximum was observed at about 6700 A. with a subsidiary maximum at about 6300 A., both attributable to chlorophyll *a*. Indication of a further maximum at about 6550 A. was obtained, which would correspond with chlorophyll *b*. Compared with spectrum determinations made on pure preparations of chlorophyll in organic solvents[2], the absorption is displaced about 100–150 A. towards the red end of the spectrum. The observations of Hubert[3] carried out on chlorophyll of living cells indicate a similar displacement.

Other measurements made with preparations of epidermis from *C. maximum* showed similar absorption spectra with a strong maximum at about 6700 A. With this leaf no qualitative differences could be detected in the light absorption by the plastids of the guard cells and those of normal photosynthetic cells of the mesophyll. Despite the earlier statements of Sayre[4], who failed to detect chlorophyll in the guard cells of *R. patientia*, there can now be little doubt that the green pigment which commonly occurs in the plastids of stomatal guard cells is chlorophyll.

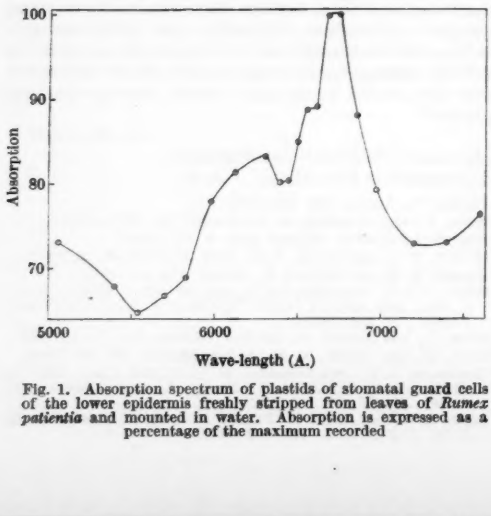

Fig. 1. Absorption spectrum of plastids of stomatal guard cells of the lower epidermis freshly stripped from leaves of *Rumex patientia* and mounted in water. Absorption is expressed as a percentage of the maximum recorded

Typical examples of diurnal fluctuations in carbohydrates of the epidermis and changes of stomatal aperture are shown in Fig. 2. Both with *C. maximum* and with *V. faba* there is evidence, during the morning, of an increase of sugars, mainly of sucrose, and later of an increase of starch; these observations are consistent with the occurrence of active assimilation in the guard cells. It is possible that increase of sugars may promote stomatal opening in the morning; but no simple relation of sugar content of the epidermis and the closure of stomata was found. Other experiments indicate that in these two plants stomatal movements and the transformations of carbohydrates in the guard cells are strongly influenced by the water relations of the leaf. A full account of this work will be published shortly[5].

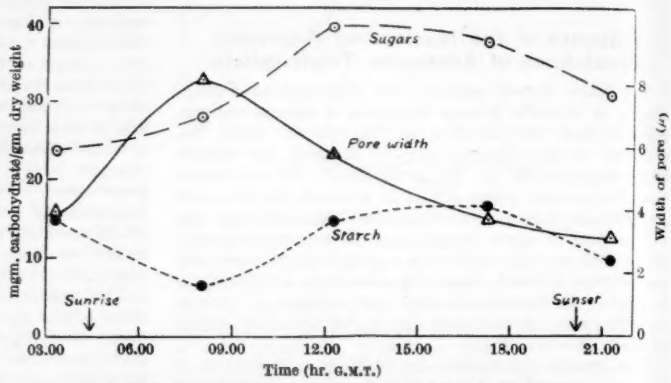

Fig. 2. Diurnal changes of carbohydrates and stomatal aperture in the lower epidermis of leaves of *Chrysanthemum maximum*

We are indebted to Mr. K. W. Keohane and Dr. W. K. Metcalf for the determination of the absorption spectra of plastids.

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Effect of Penicillin on the Pathogenicity of Penicillinase-producing *Aureus staphylococci*

It has been shown[1] that the effect of penicillin on an infection in rabbits which was ordinarily controlled by penicillin was much reduced if penicillinase-producing, non-pathogenic bacteria were present at the site of infection. Thus all rabbits died when a mixed infection caused by a penicillin-sensitive pathogenic *Pasteurella* bacteria and penicillinase-producing non-pathogenic *Aureus staphylococci* was treated with penicillin. Control animals which were infected with *Pasteurella* bacteria alone and which were treated in the same way recovered easily.

Similar results were achieved by using different combinations of pathogenic, penicillin-sensitive bacteria such as *Pasteurella* bacteria or β-*streptococci* and penicillinase-producing, non-pathogenic bacteria such as *coli*-bacteria or *pyocyaneusbacteria*.

Some experiments on the pathogenicity of the *staphylococci* used in the above-mentioned investigations gave some rather surprising results.

Eighty rabbits of the same age and weighing about 2 kgm. each were infected subcutaneously with 12-hr.-old broth cultures of penicillinase-producing *staphylococci*. The doses were 1 ml., 0·5 ml. and 0·1 ml. The mortality figures are shown in the accompanying table.

Dose	Treatment					
	Penicillin 30,000 units per day			No penicillin		
	Number	Death	Per cent	Number	Death	Per cent
1·0 ml.	10	6	60	10	0	0
0·5 ml.	20	5	25	20	0	0
0·1 ml.	10	4	40	10	0	0
Total	40	15	37·5	40	0	0

The rabbits which were treated with a daily dose of 30,000 units of penicillin had an average mortality-rate of 37·5 per cent. In the control group there were no fatal cases. The difference in mortality is statistically significant. The treated animals also had a higher rise in body temperature and a greater loss of weight than the control animals.

It is evident that the treatment with penicillin in these experiments caused an enhanced pathogenicity of the penicillinase-producing *staphylococci* for rabbits.

This investigation was aided by a grant from the Swedish National Research Council's Committee to the Armed Forces.

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Splitting of the Hæm–Globin Linkage in Hæmoglobin with Methanol

During an investigation of the biosynthesis of hæmoglobin in erythrocytes from rabbits intoxicated with phenylhydrazine, it was observed that the hæm–globin linkage in hæmoglobin was broken by methanol without addition of acids. The first extract was almost colourless or slightly yellowish in colour; but on further extraction with new portions of methanol the extracts became more and more reddish in colour, and by continuous extraction in a Soxhlet apparatus a dark red solution of hæm was obtained.

This observation was rather surprising, as no references could be found in the literature to such an effect of methanol on hæmoglobin.

To ensure that the methanol effect was not due to some peculiarity of the hæmoglobin molecule from the phenylhydrazine-intoxicated rabbits, erythrocytes from normal rabbits, pigs, horse, man and duck were extracted with methanol in the same way and with the same result.

The spectral absorption curves of the methanol–hæm solutions from these species measured in a Beckman spectrophotometer were found to be identical, and showed three maxima, one at 400 mμ, one at 495 mμ and one at 600 mμ, with decreasing intensity of the maxima in the same order.

The method of sampling the erythrocytes and preparing the hæmoglobin precipitate was found to be of high importance. I have found that the best way to get a smooth and fine precipitate from which the hæm group can be easily extracted is to use cells from citrated blood. The cells are washed twice with a slightly hypertonic sodium chloride solution, the protein is precipitated with 10 vol. of acetone, washed once with 5 vol. of methanol, brought into a funnel and extracted continuously in a Soxhlet apparatus overnight. This procedure gives a highly concentrated solution of hæm and leaves a protein powder which is only slightly coloured. The reagents used are Merck analytical preparations. The acid content of the methanol measured as formic acid was found to vary between 0·0025 per cent in newly opened flasks to 0·005 per cent in flasks which stood for a couple of weeks after opening the seal.

When methanol was added to erythrocytes, hæmolysates or to oxyhæmoglobin precipitated with acetone, gas was evolved and the colour changed from bright red to dark red. This indicates that the oxyhæmoglobin present in the system is transformed into hæmoglobin by methanol.

According to the modern view on the formation of bile pigments[1], bilirubin is bound to globin in the normal bilirubin–globin complex in the same way as that proposed by Holden[2] for the hæm–globin linkage in hæmoglobin. The bilirubin–globin complex is split by methanol into bilirubin and denatured globin[3], and one might expect a similar effect of methanol on the hæm–globin linkage in hæmoglobin. The following scheme for the methanol effect is suggested:

$$\text{Oxyhæmoglobin} \xrightarrow[-O_2]{\text{methanol}} \text{denatured hæmoglobin}$$

$$\text{denatured hæmoglobin} \xrightarrow{\text{methanol}} \text{hæm} + \text{denatured globin.}$$

Hamsik[4] has suggested that methanol is able to dislodge oxygen from oxyhæmoglobin, forming loose compounds with the hæm group, which is easily split off with acid methanol or acetone. A more reasonable assumption seems to be that methanol denatures the globin part of the molecule in such a way that the covalent linkage between the hæm–iron and the imidazole groups of globin is split, with release of oxygen and formation of denatured hæmoglobin, which then, in accordance with the above considerations, is split into hæm and denatured globin.

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Response of Cobalt-deficient Sheep to Oral Administration of Penicillin

It is now generally acknowledged that a deficiency of cobalt in the diet of ruminant animals may induce a vitamin B_{12}-deficiency, since without sufficient cobalt certain ruminal micro-organisms fail to synthesize the vitamin B_{12} needed by the host animal. Several workers have reported that the dietary vitamin B_{12} requirements of chicks and rats may be reduced by the oral administration of penicillin.

We have been investigating the influence of such a treatment on the vitamin B_{12} and cobalt requirements of sheep. Two Kerry Hill wethers were obtained from a cobalt-deficient farm in Herefordshire, individually penned, and offered a daily ration of 200 gm. hay and concentrates, and water *ad lib.* The concentrate mixture consisted of 3 parts by volume of oats, 1 part barley, 1 part peas and 1 part beans, and all these components together with the hay were grown on the cobalt-deficient farm. The consumption of concentrates by each sheep was recorded daily.

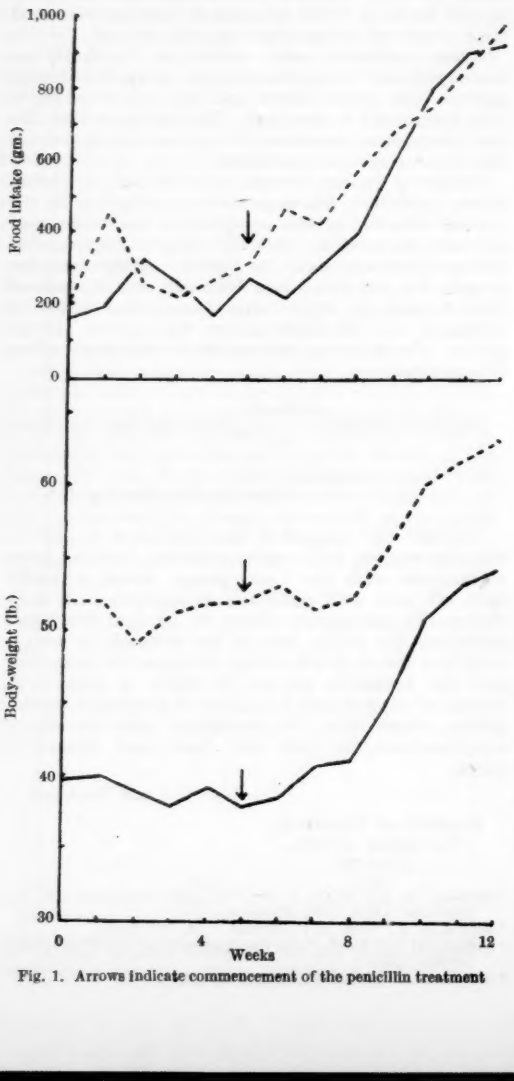

Fig. 1. Arrows indicate commencement of the penicillin treatment

Dr. R. L. Mitchell kindly analysed samples of the hay and concentrates and reported that they contained 0·06 p.p.m. cobalt and 86 p.p.m. iron, and 0·07 p.p.m. cobalt and 122 p.p.m. iron respectively. Before detailed observations were begun anthelmintic treatments reduced an originally heavy parasitic burden to reasonable limits, as judged by fæcal worm-egg counts.

When the sheep had been maintained on this routine for five weeks the penicillin treatment was commenced. Each day 50,000 units of crystalline sodium penicillin *G* dissolved in 1 c.c. of water was given *per os* to each sheep and this treatment was continued for seven weeks. The accompanying figure gives the weekly intakes of concentrates by each sheep together with their weekly changes in body-weight. From this it will be seen that for a period of about three weeks after the penicillin had been introduced there was no change in either the food intakes or the body-weight; but from the fourth week onwards the response in both cases was exactly as if cobalt or vitamin B_{12} had been administered. Since the penicillin used in this work did not contain any cobalt, the most plausible explanation for these results is that, following the penicillin treatment, there was a change in the rumen flora which encouraged the bacterial synthesis of vitamin B_{12} and increased the efficiency of utilization of the extremely small traces of cobalt in the diet.

Samples of rumen contents were withdrawn by stomach tube both before and after penicillin administration, and an examination of these supported the idea that a qualitative change in the bacterial population had, in fact, taken place.

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Influence of Folic Acid and Vitamin B_{12} on the Impairment of Nucleic Acid Synthesis in *Lactobacillus casei* by Aureomycin

A reversal of aureomycin action by folic acid and, to a lesser extent, vitamin B_{12} has been observed by us with several micro-organisms. Since aureomycin acts primarily on rapidly growing organisms[1] and since the mediation of folic acid and vitamin B_{12} in nucleic acid synthesis is known[2], it was of interest to ascertain the relationship in this respect between these vitamins and the antibiotic.

The organism employed was *Lactobacillus casei* (*A.T.C.C.* 7469). Methods of culturing, harvesting and nucleic acid determinations were as described previously[2]. A 48-hr. growth of the organism was used. A concentration of aureomycin (crystalline, Lederle) was chosen which produced half maximum growth inhibition in tube assays. The average results of duplicate experiments are given in Table 1.

Aureomycin may be observed to inhibit synthesis of both pentose nucleic acid and deoxypentose nucleic acid, and folic acid exerts a protection against this action. A higher concentration of vitamin B_{12} is required to provide similar adequate protection.

Table 1

Additions per 100 c.c. basal medium	Without aureomycin			With aureomycin (300 mμgm. per 100 c.c.)		
	Cell mass (gm. per lit.)	Pentose nucleic acid (per cent)	Deoxypentose nucleic acid (per cent)	Cell mass (gm. per lit.)	Pentose nucleic acid (per cent)	Deoxypentose nucleic acid (per cent)
Folic acid, 200 mμgm.	0·54	11·32	1·92	0·48	9·56	1·67
Vitamin B_{12}, 200 mμgm.	0·18	8·80	1·85	0·16	7·28	0·83
Folic acid + vitamin B_{12}, 200 mμgm. each	0·60	10·00	2·80	0·46	9·05	2·54
Vitamin B_{12}, 400 mμgm.	0·33	12·42	2·14	0·27	12·17	2·08
Folic acid, 200 mμgm. + vitamin B_{12}, 400 mμgm.	0·65	11·67	3·85	0·60	12·14	2·78

Interference in normal nucleic acid metabolism of micro-organisms has been observed for penicillin[3,4]. More recently, it has also been reported that cultural conditions favouring increased pentose nucleic acid content of bacterial cells enhance resistance of *Haemophilus pertussis* cells to aureomycin among other antibiotics[5].

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Tetrahydropteroyl Glutamic Acid in Serine Synthesis and Degradation

Pteroylglutamic acid (PGA) has been implicated in the synthesis of serine from glycine[1-3] and in the breakdown of serine to glycine[4], and a soluble enzyme system from pigeon liver catalysing the interconversion of serine and glycine showed a marked activation by the acid[5].

In recent studies the enzyme preparation supplemented with PGA was found to synthesize [2 — ^{14}C]-serine from [2 — ^{14}C]glycine and formaldehyde, and [3 — ^{14}C]serine from unlabelled glycine and H^{14}CHO. Formaldehyde could not be replaced by formate for the synthesis of serine in this system, even in the presence of reducing agents such as homocysteine or ascorbic acid. Since the preparation also catalysed the breakdown of [2 — ^{14}C]serine to [^{14}C]glycine and formaldehyde, it was able to catalyse the formation of [2 — ^{14}C]serine from unlabelled L-serine and [2 — ^{14}C]glycine[5].

For this reaction maximum activity was obtained with dialysed enzyme preparations when supplemented with yeast extract or a combination of adenosine triphosphate (ATP) and diphosphopyridine nucleotide (DPN), in addition to PGA. The reaction was also favoured by the addition of ascorbic acid and by anaerobic conditions. On the other hand, for net serine synthesis from glycine and formaldehyde or for net serine breakdown to glycine and formaldehyde, addition of PGA alone fully activated the enzyme preparation. These results may be explained by assuming that before activating serine–glycine interconversion, PGA undergoes enzymic reduction. ATP, DPN and yeast extract preparations are presumed to be involved in the reduction of PGA, in which ascorbic acid is known to participate[6]. In net serine synthesis or net serine breakdown the formaldehyde added or accumulated respectively is assumed to reduce pteroylglutamic acid.

The following facts are consistent with this view: (1) 5 : 6 : 7 : 8-tetrahydroPGA was more effective than PGA and other PGA derivatives in activating the enzyme system; (2) when the enzyme system was activated by tetrahydroPGA, [2 — ^{14}C]serine synthesis from [2 — ^{14}C]glycine and unlabelled L-serine proceeds without addition of other co-factors, and without the considerable lag period evident when PGA and yeast extract were added; (3) 4-aminoPGA (aminopterin), which is known to inhibit reduction of PGA to tetrahydroPGA[7], strongly inhibited serine–glycine interconversion when PGA and yeast extract were added, but not when tetrahydroPGA was added.

Leucovorin (5-formyl-5 : 6 : 7 : 8-tetrahydro-PGA) was similar to PGA in its activation of serine–glycine interconversion, and it also required the simultaneous addition of yeast extract. Heating the enzyme to 53° did not impair its activity for serine–glycine interconversion when tetrahydroPGA or PGA and yeast extract were added, but this treatment considerably diminished its activity when leucovorin was the co-factor.

These results indicate that tetrahydroPGA rather than leucovorin or N^{10}-formylPGA plays the central part in one-carbon transfers, and suggest that tetrahydroPGA combines reversibly with formaldehyde in the presence of the enzyme, possibly forming the imidazolidine derivative in which a methylene group links the N^5- and N^{10}-positions of tetrahydroPGA. It is suggested that this intermediate might then react reversibly with glycine and water to form serine, and perhaps might transfer the methylene group derived from formaldehyde to homocysteine, forming methionine by a process in which vitamin B_{12} may be involved. In the incorporation of formate into serine, formate presumably reacts with tetrahydroPGA to form leucovorin, which is then reduced by a heat-sensitive enzyme to the imidazolidin type of pteridine intermediate. A complete report of this work will be published elsewhere.

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Adult Anopheline Behaviour Patterns: a Suggested Classification

An insect, or other biting arthropod, which transmits a micro-organism by its bite must feed at least twice on the host, once to acquire the micro-organism and once to pass it on (except in the rare but possible case of a hereditary infection). Those who are interested in the transmission of the malaria parasite by *Anopheles* mosquitoes have known for many years that those species of *Anopheles* which feed on man indoors, or rest indoors after feeding and during the maturation of the eggs, tend to be more effective as transmitters of malaria, because of this close association with the human being. If the mosquito only feeds when it encounters man in the jungle and always rests outside, the chance that the individual mosquito will feed twice on a human being is evidently lessened. The use of the modern residual insecticides (DDT and other chlorinated hydrocarbons) has led to a more intense study of the feeding and resting habits of adult mosquitoes because these insecticides are applied to a house with the view of making the walls, etc., insecticidal for a long period. The focus of attention has shifted, therefore, during the past ten years, and is now mainly directed upon the behaviour of the adult *Anopheles*.

I recently produced for the Expert Malaria Committee of the World Health Organization[1] a summary of the different behaviour patterns of adult mosquitoes. I pointed out the extent to which differences in behaviour affect the insect's exposure to residual insecticides, such differences being possibly connected with the development of resistance to these chemicals through genetic or cytoplasmic selection or gene mutation.

As this discussion note has not been officially published, I have now drawn up a summary relating to this aspect of adult anopheline behaviour, believing that such a study can usefully be extended not only to the behaviour of all mosquitoes, but also to many other hæmatophagous arthropods.

Behaviour may be classified into two types as regards resting and into two types as regards feeding habits. The Greek terminology now coming into general use may be cacophonic, but has the merit of being concise.

We may distinguish: (1) *Endophily*, the habit of remaining within a man-made shelter throughout the whole or a definite part of the gonotrophic cycle. (2) *Exophily*, the habit of spending the greater part of the gonotrophic cycle out of doors. (In both cases food may be sought within or without a man-made structure.) (3) *Endophagy*, the habit of obtaining the blood meal within a man-made structure, be this a human dwelling or an animal shelter. (4) *Exophagy*, the habit of seeking the blood-meal out of doors.

In their resting and feeding habits, all anopheline mosquitoes fall within the four categories thus delineated. Examples derived from some of the better known malaria vectors of the world will now be quoted. Among mosquitoes a vast amount of further investigation remains to be done.

The accompanying four-way table serves to bring out the relationships of the four categories of malaria-vectors.

As might be expected, certain species fail to conform to such a classification; for example, *A. fluviatilis* in the second half of its gonotrophic cycle rests outside the house until oviposition. *A. aquasalis*, at least in Trinidad, is strictly exophilic, leaving the building almost immediately after a meal therein, but it feeds as much without as within the house or stable; it is thus exophilic but facultatively both endo- and exo-phagic.

	Endophagic	Exophagic
Endophilic		
	A. atroparvus (during gonotrophic dissociation)	*A. pseudopunctipennis* (N.W. Mexico) *apud* Downs
	A. culicifacies (India)	
	A. darlingi (Coastal British Guiana)	
	A. fluviatilis (South India)	
	A. funestus (Africa)	
	A. minimus (S.E. Asia)	
	A. gambiae (zoophilic race *apud* Holstein)	
Exophilic		
	A. leucosphyrus—complex (Borneo)	*A. bellator* (Trinidad)
	A. maculatus (Malaya)	*A. homunculus* (Trinidad)
	A. minimus flavirostris (Philippines)	
	A. gambiae (anthropophilic race *apud* Holstein)	

Further observations will doubtless reveal many other nonconformities, and a wide field for ecological studies thus presents itself.

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Application of a Systemic Insecticide by Trunk Implantation to control a Mealybug Vector of the Cacao Swollen Shoot Virus

It has previously been reported that dimefox (*bis*-dimethylamino fluorophosphine oxide) when applied to the root system of cacao trees can control *Pseudococcus njalensis* Laing, the common mealybug vector of the swollen shoot virus in the Gold Coast[1,2]. The toxic action of the chemical persists within the tree for about eight weeks.

When the chemical is applied to the soil around the trees relatively large doses are required, as presumably only a proportion of the chemical is taken up by the trees. Because of this, and following some preliminary work on trunk implantation by members of the research team of Pest Control, Ltd., a joint experiment was laid down to test this method. From the preliminary experiment it was expected that, by applying the chemical directly into the tree, much smaller doses would achieve results similar to those obtained when the chemical was applied to the soil.

In this joint experiment the base of the tree was brushed with a disinfectant solution, and holes were bored at points around the trunk at ground-level by means of a pneumatic drill, operated from a portable, petrol-driven compressor. A fixed jig attached to the drill ensured that the holes were bored at an angle of 45° to the vertical and were driven to a standard depth of 3·5 in. The size of drill was chosen so that the required volume of chemical nearly filled the holes.

Each dosage-level as described below was tested at two hole spacings, namely, 2 and 4 in. between centres, to see if the radial and tangential movement of the insecticide was influenced by the distance between the holes.

The dosages used were 75, 150, 225 and 300 parts per million of the weight of the aerial part of the trees, assessed from the girth one foot above ground-level; these doses were approximately 1/12, 1/6, 1/4 and 1/3 of those used in the soil application method.

The relation between the weight of the aerial part of a tree to its girth at one foot from the ground had been established during the soil application experiments referred to above[2]. The holes, after receiving the required dosage of chemical, were sealed with plugs and covered with a pliable, antiseptic wax.

The layout consisted of six blocks, each with eight plots (of seven trees apiece) randomized for the eight treatments—four dosage levels at the higher and lower number of holes respectively. The trees were chosen after an examination had shown that a reasonable population of mealybugs was present. In order to check that no drastic change took place in the mealybug population on untreated trees during the course of the experiment, forty-two trees scattered around the perimeter of the treatment blocks were felled, half at the beginning and half at the end of the experiment, and the mealybugs on them counted.

The treated trees were cut down six weeks after treatment and the surviving mealybugs counted. All treatments showed a great decrease in the number of mealybugs. At the highest level of dosage (300 p.p.m.), an average of one mealybug was found per tree, including the pods, on which the insects tend to be more persistent.

On the check trees cut down at the beginning and at the end of the experiment the number of mealybugs per tree varied from 19 to 16,656, with an overall average of 3,770. Only four of the check trees had less than 100, and eleven less than 1,000 mealybugs.

A summary of the results on treated and untreated trees is shown in Tables 1 and 2.

Table 1. Summary of Results for Treated Trees

Treatment		No. of trees	Total No. of mealybugs on 42 trees	Mean No. of mealybugs per tree
Dose level (p.p.m.)	Holes every			
75	2 in.	42	1,178	28·0 } 31
	4 in.	42	1,411	33·6 }
150	2 in.	42	209	5·0 } 20
	4 in.	42	1,493	35·5 }
225	2 in.	42	314	7·5 } 4
	4 in.	42	62	1·5 }
300	2 in.	42	50	1·2 } 1
	4 in.	42	43	1·0 }

Table 2. Summary of Results for Untreated Trees

Location		No. of trees	No. of mealybugs on 7 trees	No of mealybugs per tree
Tafo 1	At the beginning of experiment	7	31,193	4,456
Tafo 2		7	36,797	5,257
Bunso 1		7	32,274	4,611
Tafo 3	At the end of experiment	7	27,226	3,889
Tafo 4		7	29,906	4,272
Bunso 2		7	927	132
Bunso 3		7	10,088	1,441

A statistical analysis of the results has shown that, using dimefox with this trunk implantation method, and under the conditions of the present experiment, a dose of 250 p.p.m. on the estimated aerial weight of the tree may be expected to reduce the mealybug population to about one per tree. If the mealybugs on the cacao pods are ignored, a dose of 160 p.p.m. may be expected to give a similar result.

Further experiments are in progress to establish whether the drilling of holes at the root crown, and the repeated application of the chemical which is necessary at intervals of eight weeks, has any deleterious effect on the growth and yield of the trees.

The work described above was carried out jointly by members of the staff of the West African Cacao Research Institute and Pest Control, Ltd., and full acknowledgment of the part played by them will be made when a detailed report is prepared for later publication. The design of the experiment and the statistical analysis of the data were undertaken by Mr. R. Wickens, of the West African Cacao Research Institute. Thanks are due to Mr. B. M. Church, of Rothamsted Experimental Station, for advice on the layout, and to the Director of the West African Cacao Research Institute and the Managing Director of Pest Control, Ltd., for permission to publish the results.

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Field Life-histories of Four Species of *Calathus* (Coleoptera, Carabidae)

During October 1950–August 1952 populations of four beetles, *Calathus erratus* Sahlb., *C. fuscipes* (Gze.), *C. mollis* (Marsham) and *C. melanocephalus* (L.), occurring together on coastal dunes in Anglesey, were sampled regularly. Callow imagos of all species were found in late May and early June, this being probably the only period of emergence, synchronous pupation having occurred throughout the populations during April. Excepting *C. fuscipes*, older imagos, presumably of the previous year's emergence, occurred with the callows. Both males and females of this older fraction contained ripe gametes in what is believed to have been their second summer as adults; examination of the ovaries showed that they had produced eggs at least once previously. During June and July about half the active populations of *C. erratus* and *C. mollis* consisted of the older fraction. Maximal activity for the whole adult populations occurred during July and August in *C. erratus* and *C. fuscipes*, the numbers of trapped animals then declining to the virtual disappearance of adults of these species in October. Some adults survived the winter to reappear in the following spring. *C. mollis* and *C. melanocephalus* adults, on the other hand, had their peak during September and early October; the numbers trapped decreased after this although adults were present throughout the year. In *C. erratus* and *C. fuscipes* the egg-laying season extended through July, August and September, the larvæ overwintering in the final (third) instar. Egg-laying in *C. mollis* and *C. melanocephalus* occurred during August–February with a peak in the autumn; overwintered adults may have laid eggs in July. In both species larvæ of all three instars were found in winter. As mentioned above, pupation occurred in all four species during April. This synchrony suggests that pupation was triggered by an environmental factor; the fate of any larva not then ready to pupate is unknown.

Larsson[1] divides Danish Carabidae into 'spring-breeders' and 'autumn-breeders', placing the species

of *Calathus* studied in the latter group. However, the present investigation indicates that *C. mollis* and *C. melanocephalus* lay eggs during autumn and winter, at least in Anglesey. Lindroth's[2] parallel system of 'imaginal overwinterers' and 'larval overwinterers' is similarly difficult to apply. Individual carabid imagos were supposed heretofore to reproduce during one breeding season only. However, other species of Carabidae, especially those reproducing in autumn and winter, may be expected to show the phenomenon of producing gametes in one breeding season, overwintering and producing them again in the next. The long period between emergence and maximal activity in *C. mollis* and *C. melanocephalus* may be connected physiologically with late egg-laying in these species. It is relevant to note that the larvæ of the two species with an earlier peak spend the whole winter in the third instar.

This work was carried out under a Nature Conservancy Research Studentship.

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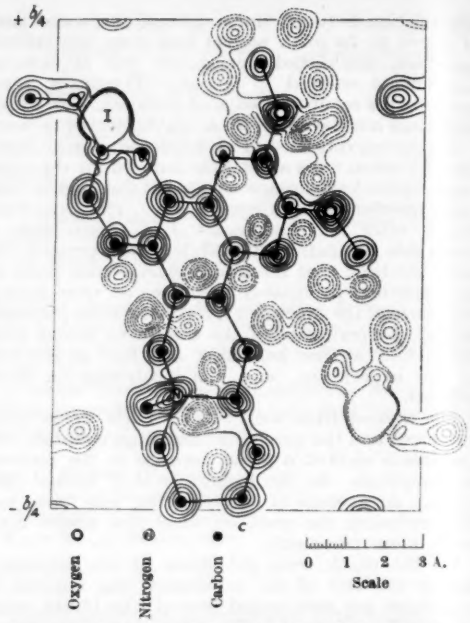
Structure of a Derivative of Cryptopleurine

Cryptopleurine is an alkaloid isolated in 1948 by de la Lande[1] from *Cryptocarya pleurosperma*. It has a very high toxicity approaching that of strychnine, possesses marked vesicant properties of the same order as the nitrogen mustards[1], is a mitotic poison[2,3] and, in small concentrations, stimulates nerve regeneration[4]. Due to the interest in its physiological properties, attempts have been made to determine the molecular structure of this alkaloid by chemical techniques combined with spectrophotometric studies in the infra-red and ultra-violet regions; but no conclusion regarding a structural formula could be reached[5]. Because of the limited success of the chemical and spectrophotometric techniques, a concurrent strueture analysis by X-ray diffraction was initiated when a suitable 'heavy-atom' derivative was available. The methiodide of the alkaloid was unsuitable for X-ray analysis because it crystallized in very fine needles and was optically active. However, when cryptopleurine methiodide was boiled with 20 per cent aqueous potassium hydroxide and recrystallized from water, suitable crystals of an isomerized and racemized product, *dl-iso*cryptopleurine methiodide, were obtained[5]. It was this latter compound which was subjected to analysis.

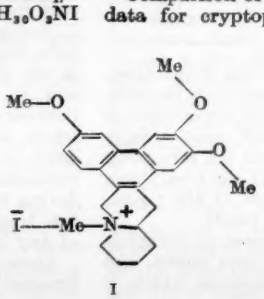
Rotation and Weissenberg photographs yielded the unit cell dimensions: a, 9·95; b, 24·2; c, 9·95 A.; β, 112°. The space group was determined as $P2_1/n$ and the density calculated for four units of $C_{21}H_{30}O_2NI$ is 1·548, the measured value being 1·54. The first stage in the analysis was the location of the iodine atoms by Patterson projections. The next stage involved locating the 29 'light' atoms in the asymmetric unit, that is, 25 carbons, 3 oxygens and 1 nitrogen. The only information available about the compound was (*a*) the empirical formula, (*b*) the presence of three methoxyl groups, and (*c*) the resemblance between the ultra-violet spectrum of the alkaloid (also of *iso*cryptopleurine methiodide) and the spectra of phenenthrene and triphenylene. Hence it was necessary to limit ourselves to the initial assumption that the 29 atoms were of equal scattering power. The atom sites had to be determined by a direct method since no molecular model could be proposed. The solution to this problem was attained by the use of partial three-dimensional data, applying generalized projections[6] in a new manner to be described in a separate publication. The molecule is outlined in the accompanying figure, which shows the distribution of electron-density as it would appear viewed down the *a*-axis of the crystal. This projection was derived from $1kl$ intensity data, and the reliability factor, $\Sigma|F_o - F_c|/\Sigma|F_o|$, for the 388 observed reflexions of this set was 0·19 at this stage of refinement.



The electron-density distribution $\rho(y,z)$ derived from $1kl$ data. For the purpose of illustration, the contours corresponding to one molecule are in full lines and those of the symmetry-related molecule in broken lines

The constitutional formula for *iso*cryptopleurine methiodide is given by I and that of the parent compound by II. A possible systematic name for *iso*cryptopleurine is 2,3,6-trimethoxyphenanthro [9,10-*b*] quinolizidine. This analysis appears to be the first record of the phenanthro-[9,10-*b*] quinolizidine ring system.

Comparison of the available chemical and physical data for cryptopleurine and *iso*cryptopleurine has



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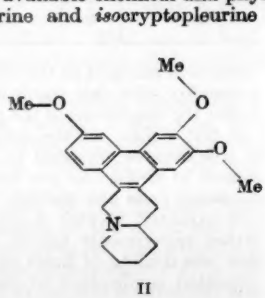

II

indicated that the two compounds are similar in structure and that the difference probably lies in the steric arrangement around the nitrogen atom. Since the molecular structure of *iso*cryptopleurine is now known, elucidation of the relationship is being attempted[7].

We wish to thank Drs. J. R. Price and E. Gellert, of the Organic Chemistry Section of the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, for making this problem available to us and for supplying crystals suitable for analysis. This opportunity has enabled us to illustrate more clearly than in the case of lanostenol[8] that X-ray analysis can rapidly and unequivocally fix the molecular structure and stereochemistry of complex organic compounds before chemical studies have offered any formulation of the molecular structure, and, furthermore, that such analyses can be carried out with little, if any, chemical information.

Full details of the structure analysis and stereochemistry of *iso*cryptopleurine methiodide will be given at a later date.

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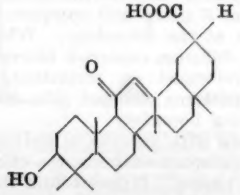
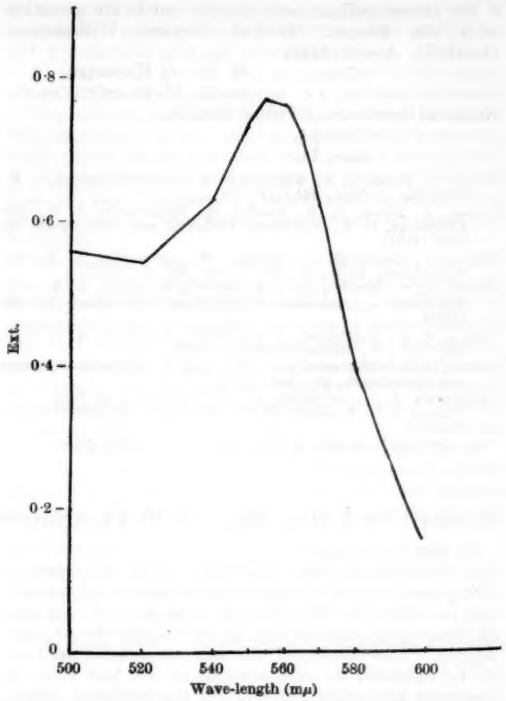
Metabolism of Glycyrrhetinic Acid in Human Subjects

In a series of publications Groen, Pelser, Frenkel, Kamminga and Willebrands[1-6] have reported on the successful treatment of Addison's disease by extract of liquorice, glycyrrhizinic acid or glycyrrhetinic acid. It was shown that either the crude liquorice extract or its active component produced an effect on electrolyte metabolism which was entirely comparable to that of deoxycorticosterone, in a similar way to that already demonstrated by Borst *et al.*[7] in normal individuals.

Following a suggestion made by Groen and his co-workers, we have recently worked out a method by which the urinary excretion of glycyrrhetinic acid in amounts as small as 0·01 mgm. per 24 hr. could be determined without difficulty[8]. Using this method,



Glycyrrhetinic acid



however, no glycyrrhetinic acid could be detected in the urine of a patient with Addison's disease who was treated with 2·28 gm. of glycyrrhetinic acid per day orally. The urine of a patient with a jejunal ulcer who received 2·5 gm. of glycyrrhetinic acid per 24 hr. by mouth also failed to show a trace of this compound.

Further investigation was therefore directed towards the detection of possible catabolites of glycyrrhetinic acid. It was found that, after administration of glycyrrhetinic acid, extraction of the urine with butanol at room temperature yielded a substance which gave a red colour with 71 per cent sulphuric acid in methanol solution. Up to the present, we have examined a total of twenty urine samples from different patients during periods when no glycyrrhetinic acid was administered and thirty samples of urine from periods during which this compound was given. Of the first-mentioned twenty samples only one gave a positive reaction with sulphuric acid, and this was the urine collected on the first day after the interruption of the treatment. The thirty samples collected during the treatment with glycyrrhetinic acid all gave a positive reaction with the sulphuric acid reagent. The optimal conditions for development of the red colour are being studied. Glycyrrhetinic acid itself does not give this reaction.

The accompanying figure shows the absorption spectrum of the red solution, as measured with the Beckman spectrophotometer. The absorption maximum lies between 555 and 560 mμ.

The investigation will be continued, and an attempt will be made to isolate this glycyrrhetinic acid derivative in the pure state and to identify it. It is hoped that this may throw new light on the mechanism of action of glycyrrhetinic acid on water and electrolyte metabolism in human subjects.

The investigations were carried out in co-operation with the Second Medical Service, Wilhelmina-Gasthuis, Amsterdam.

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Proposal for a New Æther-Drift Experiment

It has been suggested by H. Littman Furth[1] that the Michelson–Morley experiment might be repeated, using microwaves in place of light waves, by measuring the resonant frequency of a cavity with the axis of the cavity successively in two directions at right angles. The theory of the experiment would have to be modified to take account of the fact that the resonant frequency depends on the sectional dimensions of the cavity as well as on its length, but the experiment seems to be essentially similar to the original optical experiment. It is potentially more accurate because frequencies can be compared with a higher precision than wave-lengths.

Techniques for the precise measurement of frequency in the microwave region have been developed at the National Physical Laboratory, and we are therefore in a position to make an assessment of the difficulties involved in the proposed experiment and the accuracy that might be expected in practice.

Frequency standards are stable to a few parts in 10^{10} per hr., and a change of frequency in an observation lasting only a few minutes could be measured with an accuracy of $\pm$ 1 part in 10^9 or better if a certain amount of averaging is allowed. Frequency comparisons with this accuracy have been made[2] at a frequency near 9,000 Mc./s. which would be suitable for the experiment. The accuracy of measuring the resonant frequency of a cavity is limited, however, by the sharpness of resonance and not by the measurement of the frequency of the generator. Although an accuracy of $\pm$ 1 part in 10^8 has been achieved[3,4], it would not be easy to improve much on this figure, and it is doubtful whether such an experiment could be made with an accuracy greater than that of the Michelson–Morley experiment.

A more promising procedure would be to use the cavity resonator to control the frequency of the oscillator[5]. An oscillator controlled in this way at a frequency near 9,000 Mc./s. was stable in frequency to 1 part in 10^9 per hr.[2] and was compared with the standard quartz oscillator with a precision of 1 part in 10^{10}. The frequency of oscillation is governed mainly by the resonant frequency of the cavity, and anything causing a change in this resonant frequency of 5 parts in 10^9—the amount expected according to the classical theory—would change the oscillation frequency by almost exactly the same amount. However, it depends to some extent on the circuit conditions and is, for example, very susceptible to mechanical vibration. The rotation of the resonator without causing frequency-changes of more than 1 part in 10^{10} would therefore present considerable problems. The precision of measurement is considerably higher than that of the Michelson–Morley experiment, and there would seem to be a reasonable chance of obtaining an accuracy at least ten times as great if sufficient care were taken. Some physicists have felt that the Michelson–Morley experiment formed a rather unsatisfactory basis for a theory as important as that of relativity, because the authors claimed to obtain a small but definite effect and not a null result as is assumed in the theory. It might, therefore, be worth while to carry out this alternative experiment, especially as much of the equipment required is already in existence. It is hoped that the work will be attempted here when other commitments allow.

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Electrophoresis and Gel Strength

A curious phenomenon has been noted in recent work on the electrophoresis of sodium carrageenate. This polysaccharide occurs in the red seaweed, *Chondrus crispus*, and is composed mainly of *d*-galactose sulphate units linked in the 1–3 positions. Cations associated with the sulphate can become ionized to make the molecule a polyelectrolyte.

Electrophoresis was studied at 25° C. in a Tiselius apparatus equipped with a Longsworth scanning device. The concentration of carrageenate was 0·4 per cent in an acetate buffer of *p*H 5·5 and ionic strength 0·05. The current was 10 m.amp.

The electrophoresis diagrams showed a sharp, high ascending peak with a diffuse irregular peak on the descending side. The descending peak flattened more quickly than the ascending one. When the peak asymmetry was well developed, the vertical slit was removed and the image of the cell was studied visually on a ground-glass plate. For different positions of the knife-edge, clearly defined patterns of refractive index gradients appeared as shown in Fig. 1. These were usually more evident for the descending boundary. Thus the diffuse and irregular diagrams produced when the film scanned the vertical slit arose from a sharp and complex distribution of concentration at the boundary. When the current was stopped, diffusion occurred, blurring the pattern, which was reformed on restarting. On current reversal the patterns changed sides to fit the appropriately moving boundary.

In forty runs with samples of sodium carrageenate prepared by different methods, the effect was present to a varying extent. It was found that coating the interior of the cells with a thin layer of paraffin did

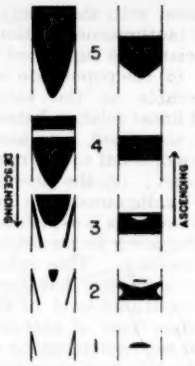

Fig. 1. Drawings of the patterns obtained in the image of the cell when the knife edge is raised from positions 1 to 5. No. 1 represents the lowest position of the knife edge in which part of the light is cut off. If the knife edge is raised beyond No. 5, the beam is completely cut off to give the base line

not reduce the effect. Thus it was not caused by the solution wetting the walls of the cell. Increasing the ionic strength increased the effect; thus it was not due to conductivity changes across the boundary. It occurred in solutions of high or low viscosity. Irregularities in the electrophoresis diagrams of carrageenin have also been noted by Cook, Rose and Colvin[1].

In one series of fractionations, five samples of sodium carrageenate were prepared having essentially equal values of intrinsic viscosity (1,700 ± 100 gm.$^{-1}$cm.$^{-3}$), sulphate content (23·6 ± 0·7 per cent) and electrophoretic mobility (2·95 ± 0·10 × 10^{-4} cm.^{2} sec.$^{-1}$ volt^{-1}). However, the fractions differed markedly in gel strength as measured by the force required to penetrate a fresh surface of the gel with a flat plunger. Gels were made by allowing a hot,

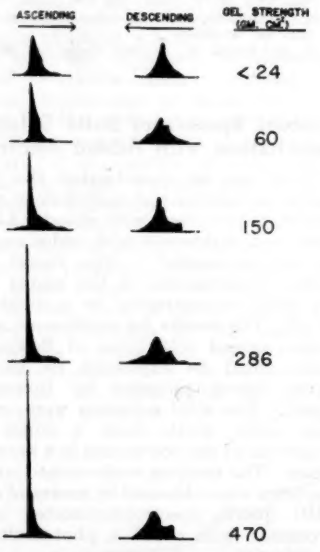

Fig. 2. Changes in the electrophoresis diagrams with changes in gel-strength. For the ascending boundaries the mean time and distance of migration were, respectively, 110 ± 3 min. and 63 ± 3 mm.; they were 58 ± 5 min. and 28 ± 2·5 mm. for the descending boundaries. The descending peaks were flat at the end of the run, and therefore they are shown after migrating about one-half the length of the cell

2 per cent solution of sodium carrageenate in 0·05 *M* potassium chloride and 0·05 *M* acetate buffer at *p*H 5·5 to cool and set overnight.

As shown in Fig. 2, the asymmetry of the peaks obtained in electrophoresis of 0·4 per cent solutions of the fractions increased with increase in gel strength. The sharpness of the ascending peak was increased, while the descending peak showed greater irregularity. A visual examination of the image of the cell showed that the fine structure of gradients in the descending peak (Fig. 1) was more pronounced for high gel strength.

The solutions used in electrophoresis were not gels. However, it is possible that a gel-like structure would develop in the solution under the conditions of electrophoresis. Boundary movement would then be due to the hydrostatic pressure built up by electro-osmosis through a gel. The leading and trailing ends of such a gel might show complex distributions of concentration differing from the classical pattern obtained with proteins. The effect would increase with increasing gel strength, as shown in Fig. 2.

It is possible that the marked asymmetry of the peaks found in the electrophoresis of concentrated solutions of certain proteins could be associated with this effect.

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Conductometric Detection of Ions in Paper Chromatograms

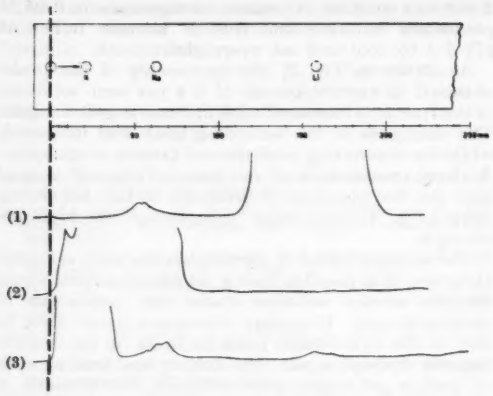
After having completed the first of a series of experiments on the conductometric detection of ions in paper chromatograms, I read the communication by Hashimoto and Mori[1] on high-frequency papyrography of salts. The authors did not obtain satisfactory results with the conductometric detection of the ions.

The alkali metal ions being among the most difficult ones to detect in paper chromatograms, I tried a conductometric method for their detection. The chromatograms were prepared with aqueous solutions of the chlorides and of the perchlorates of lithium, sodium and potassium, the ascending mobile phase being a mixture of amyl alcohol and methyl alcohol 3 : 7 by volume[2].

After drying, the paper strip was moved forward at constant speed between two small steel cylinders having a constant d.c. potential difference ranging from 4 to 80 volts. At intervals of 3 sec. (corresponding with 0·75 mm. distance on the chromatogram) the current intensity was read on a Cambridge spot galvanometer (coil resistance 450 ohms).

In this way the spots of the chromatogram reveal themselves by their high conductivity as compared with the 'empty' parts of the paper.

Curves 1, 2 and 3 in the accompanying illustration show some typical results. Each of the ions is detectable in presence of the other two with satisfactory sensitivity. However, if much sodium is present with little potassium, the low peak of the latter ion is absorbed by the high and broad one of the former. The sensitivity is roughly proportional to the inverse of the atomic weight and extends to about 0·5 μgm. for lithium, 1 or 2 μgm. for sodium and 3 or 4 μgm.



for potassium. 0·5 μgm. of lithium could be found even in presence of 500 μgm. of sodium.

Good separations were obtained also with the perchlorates, though the sensitivity of the method is then less satisfactory than with the chlorides.

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Photo- and Semi-conductance in Molecular Single Crystals

The following conclusions have arisen from work undertaken recently.

(1) Photo-conductance[1] in molecular single crystals of the anthracene type is not an effect due primarily to impurity centres, since the dependence of photo-conductance on wave-length reproduces all inflexions of the ultra-violet absorption curve of the crystal. Thus the photo-conductance of these molecular crystals is to be distinguished from that of many inorganic substances.

(2) Photo-conduction in anthracene, etc., should not be interpreted as a semi-conduction effect due to the conversion of the light into thermal energy, since, first, the amount of energy absorbed, which we have measured, is altogether inadequate, and, secondly, the current in the external circuit has been shown to depend on the number of quanta, rather than on the total energy absorbed. One electron enters the circuit for every 10^4 quanta absorbed (approximately). Most adsorbed light is re-emitted[2].

(3) To every region of conduction in the crystal there corresponds an electronic transition in the vapour. (A close relation between the crystal and the vapour spectra has been established[3] in regions above 2000 A. although such a relation is not true below 2000 A.[4].) This conclusion applies with certainty to the singlet–singlet transitions and is probably also true for singlet–triplet transitions. In the latter case a simple interpretation of the results of other workers[5,6] on semi-conduction becomes possible, namely, the energy derived from the temperature dependence of the conductance (anthracene[5], 13,300 cm.$^{-1}$) is associated with the energy of excitation to the triplet-level (anthracene solution[7], 14,700 cm.$^{-1}$).

Such an association is supported by the following considerations: (*a*) the population of the triplet-level becomes appreciable at the temperatures used; (*b*) the observed linear relation between log i and $1/T$ is immediately accounted for, assuming that the current, i, is proportional to the number of electrons in the upper band; (*c*) the decrease in activation energy of semi-conductance with an increase in the number of aromatic rings is explained, since in general the energy of excitation to the triplet-level decreases with such an increase. This rule, which is being investigated theoretically, has exceptions, one of which is that the triplet-level of coronene lies at a higher energy than that of anthracene. However, the energy from semi-conductance of polycrystalline materials is greater for coronene than for anthracene in a very similar, though possibly fortuitous, proportion.

There is accordingly reason for believing that both photo- and semi-conduction are understandable in terms of the electronic transitions which are observed spectrally for these substances.

This work is being continued by two of us (D. J. C. and L. E. L.) and we shall publish a full theoretical and experimental account later. Dr. T. Iredale is thanked for his interest and encouragement, and the Vacuum Oil Co. for a scholarship (to D. J. C.).

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Fluorescent Spectra of Solid Solutions of Naphthalene with Added Anthracene

Some time ago we investigated the fluorescent spectra of solid solutions of naphthalene with added naphthacene, naphthalene with added 1,2,5,6-dibenz-anthracene, and anthracene with added naphthacene, under X-ray excitation[1]. We found that the fluorescence characteristic of the added compound increased with concentration to a maximum, and then fell off. The results for anthracene with added naphthacene agreed with those of Bowen[2], and all the results could be explained on the basis of the exciton theory proposed by Bowen and his colleagues[2,3]. The solid solutions were prepared by dissolving under gentle heat a small, carefully weighed amount of one compound in a known amount of the other. The samples were excited with X-rays, and the spectra were obtained by means of a Beckman Model *DU* quartz spectrophotometer used as a monochromator, with a 931-A. photomultiplier tube used as detector.

Some subsequent results obtained in the same manner from crystals of naphthalene with added anthracene are more complex; but a tentative explanation may be given with the aid of the exciton

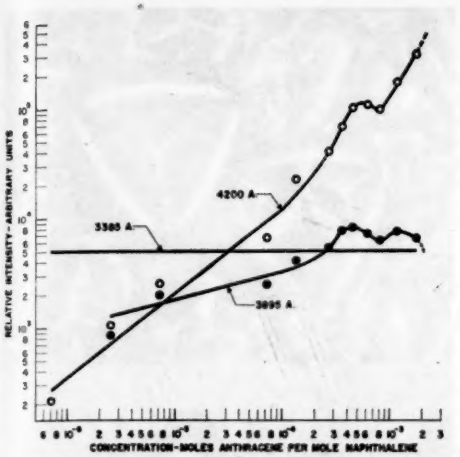

Fig. 1. Intensity of the 3895 and 4200 A. anthracene bands relative to the 3385 A. naphthalene band as a function of concentration

theory. The spectra consisted of fairly broad overlapping bands, similar to those found previously. The maxima of the bands occurred at 3385, 3505, 3700, 3895, 4200 (app.), 4340, 4600 and 4880 A. The first band is attributed to naphthalene and the remainder to anthracene. The intensities of the anthracene bands at 4200 A. and 3895 A., relative to the naphthalene band at 3385 A. (arbitrarily normalized to an intensity of 5000), are given in Fig. 1.

The results may be explained if it is assumed that, in addition to the transfer of excitation energy from the naphthalene molecules to the anthracene molecules by the exciton process, a vigorous fluorescence of the anthracene molecules by themselves also takes place. As the concentration of anthracene increases the fluorescence by transfer of excitation energy increases until it reaches a maximum at a molar concentration of about $4 \cdot 5 \times 10^{-4}$. When the concentration is further increased, the fluorescence by transfer of excitation energy decreases and the naphthalene fluorescence is quenched, while the fluorescence of the anthracene molecules increases steadily. The anthracene bands at 3505 and 3700 A. arise primarily from transfer of excitation energy, while those at longer wave-lengths arise from a combination of transferred excitation energy and molecular fluorescence.

The wave-length of the principal anthracene band strengthens the preceding arguments. In systems where the added compound has no vigorous fluorescence of its own, such as those previously studied by us, the wave-lengths of the bands of the added compound depend upon the matrix but do not change with concentration. In the present experiments, however, the wave-length of the principal anthracene band increases with concentration as shown in Fig. 2, showing the transition from fluorescence by transfer of excitation energy to molecular fluorescence. The wave-length of the band in pure solid anthracene under X-ray excitation[1] is 4475 A.

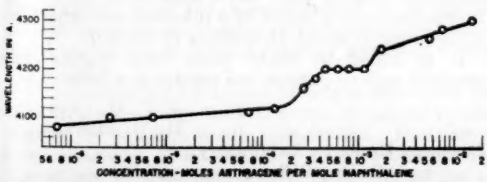

Fig. 2. Wave-length of the principal anthracene band as a function of concentration

This work was carried out in the Department of Physics, University of British Columbia, Vancouver, Canada, and will be continued shortly by one of us (F. L.) at the National Research Laboratories, Ottawa, Canada. Grateful acknowledgment is made to the Defence Research Board (Contract *D.R.B.* 12 (*S.C.*)) and the National Research Council of Canada for financial support.

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Angular Correlations between *K*-Conversion Electrons

THE angular correlations between successive conversion electrons are particularly interesting because, in contradistinction to the correlations between the unconverted γ-rays, they also depend on parity[1]. They are, however, difficult to investigate: the various conversion lines must be separated, and scattering effects should be carefully avoided. Early experiments[2] did not meet these requirements and remained inconclusive.

In an attempt to overcome these difficulties with reasonably simple means, I have investigated the correlations between the *K*-conversion electrons from the two-step isomeric transitions in bromine-80 and mercury-197 (electron energies 35 and 23, and 82 and 51 keV., respectively), employing extremely thin sources and two scintillation spectrometers in conjunction with single-channel kicksorters[3]. Residual scattering effects in the sources were brought under control by using a randomized block method for taking observations[4]. The following results have been obtained:

(*a*) Bromine-80. Expanding the correlation function into Legendre polynomials, with the normalizations $a_0 = 1$ and $P_n(1) = 1$, as usual, there is only a second-order term with $a_2 = 0 \cdot 292 \pm 0 \cdot 024$ (estimated standard deviation; the significance[5] is that of a t of six degrees of freedom). This is consistent with the assignment $M3/E1$ suggested by Segrè and Helmholz[6] from life-time – energy considerations, and excludes both $M3/M1$ and $M3/(M1 + E2)$.

(*b*) Mercury-197. The two transitions are known to be $M4$ and $E2$ from conversion, life-time – energy and shell theory considerations[7]. The theoretical correlation coefficients are then $a_2 = 0 \cdot 450$ and $a_4 = 0 \cdot 032$; but the intermediate state has a half-life of 7 or 8 mμsec.[8], so that attenuation due to solid-state interactions can readily occur. It was found that one source prepared under conditions where the aluminium base film might have been slightly oxidized exhibited complete isotropy. Three properly prepared sources showed the same anisotropy $W(180)/W(90) - 1$ of

0·65, which did not change during 48 hr. Exact measurement on the strongest of these sources yielded $a_2 = 0{\cdot}3533 \pm 0{\cdot}0066$ and $a_4 = 0{\cdot}0258 \pm 0{\cdot}0081$ (t of five degrees of freedom; on the variance-ratio test a_4 is significant on the 2 per cent level). Allowing for the influence of scattering, the experimental value of a_2 is *c.* 18 per cent lower than the theoretical one.

A detailed report of these experiments will be communicated in due course to the *Proceedings of the Physical Society*.

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March 11.

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Etch Trigons on Diamonds

In the course of an investigation on the effects of high temperatures on diamonds, a new variation of surface etching was encountered which apparently has not been observed before. The etching agent was simply air, the temperature 1,400° C., the time of etching 2 min. Under these conditions etch trigons were formed on a (111) cleavage face, which was slightly polished. The occurrence of such etch trigons is known.

Similar to the triangular growth figures standing out from {111} faces of many natural diamond octahedrons, these etchings show a parallel orientation, and the negative growth trigons are orientated anti-parallel. The etch trigons have one more point in common with positive growth triangles, namely, that their sides are always concave when looking from the centre of the trigon towards the sides. Negative growth trigons always have straight sides.

Many of the etch trigons show what may be called bridges (Fig. 1). The sides of the trigons can be clearly seen; their directions are given by the crystallographic symbol <111>. They are fairly wide and appear to be triangular annular plateaux. From the centre of the sides flat bridges have formed perpendicular to these sides. These bridges meet in the centre of the trigon and are of the form <211>. In each of the three compartments formed by the bridges there is a tiny protruding four-sided irregular pyramid. If the edge of one of these tiny pyramids, which starts from a corner point of the large surrounding annular trigon, was a [110] direction, as one might perhaps expect, then the two other edges arranged symmetrically with respect to the first one would also be of the type <110>, but the fourth edge, running from the top of the tiny pyramid to the centre of the trigon, would be a <411> direction. However, the height of these pyramids is much smaller than expected, and this also applies to the height of the regular three-sided pyramids of these trigons, which do not show the bridge formation. Whereas the sides of such a trigon are about 10 microns, the height of the pyramid is only 1 micron. If the edges of this three-sided pyramid were <110> directions, the height should have been about 8 microns.

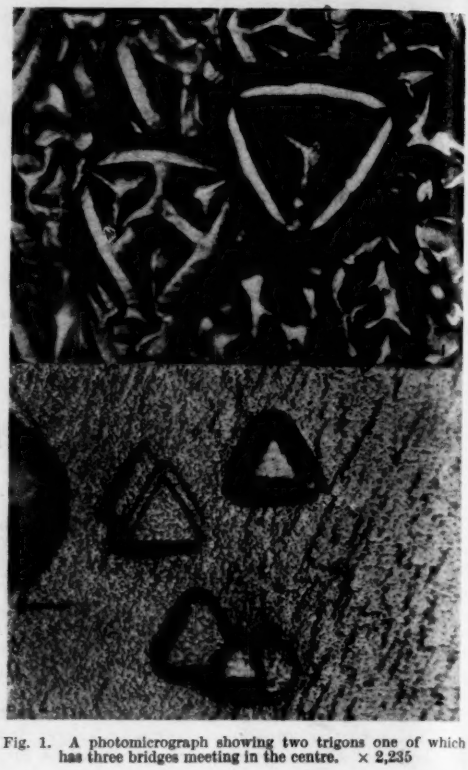

Fig. 1. A photomicrograph showing two trigons one of which has three bridges meeting in the centre. × 2,235

Fig. 2. Large negative etch trigons on a (111) face of a diamond octahedron. × 425

It was also observed that these etch trigons, especially the well-developed ones without bridges, seem to be arranged along spirals.

The trigon sides and bridges are at a lower level than the surrounding etched crystal face. This means that, approaching the trigon from the outside, there is a fairly steep decline to the plateau-level, and from this level the pyramid is protruding. On some parts of the etched surface of the diamond many of these bridged trigons were found, and on other parts none at all.

Another type of etch trigon also occurred (Fig. 2). This is in the form of a depression in the surface, its sides being fairly straight, with the bottom of the depression flat except for irregular very tiny etched patches. These trigons are usually very much larger than those with cross-bridges. Whereas the flat-bottomed trigons may have lengths of side up to 75 microns with a depth of 9 microns, the other type is the order of about 10 microns or smaller.

It is hoped to study these etch trigons more carefully and to publish the results at a later date.

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H. R. Simpson

Diamond Research Laboratory,
P.O. Box 916,
Johannesburg. Nov. 24.

Method for the Study of Corrosion Phenomena

MANY metals and alloys show passivity in strong acid solutions, although, on thermodynamic grounds, one might expect their oxides to be soluble in such solutions[1]. The group of alloys known as stainless steels show this type of 'kinetic' passivity to a marked extent. In order to understand the behaviour of such alloys better, corrosion experiments at constant potential have been carried out in various solutions. The potential was maintained with the aid of a potentiostat described elsewhere[2].

The results are found to depend on steel composition, solution and other factors; but Fig. 1 is a typical example showing that corrosion is rapid at high potential, is low at some intermediate values, then increases to a maximum and finally falls to very low values again. The steel used in this experiment was an 18/8 chromium–nickel steel, the solution was 20 per cent sulphuric acid and the temperature 25° C.

Such results can be explained by assuming that the rate of corrosion of oxide-covered metals is controlled by the rate at which oxide dissolves. This in turn depends on the exact composition of the oxide. Dissolution is rapid at high potentials, where the oxide is presumably oxidized beyond its normal stoichiometric composition. Iron, which is not readily oxidized beyond the trivalent state in acid solution, does not show a noticeable increase in corrosion-rate at high potentials; but alloys containing chromium do, because chromium is more easily oxidized under such conditions.

The corrosion product at high potential is, in fact, found to contain mainly hexavalent chromium and only traces of the trivalent ion. The range of intermediate potential over which there is no appreciable corrosion corresponds, it is thought, to conditions favouring oxides having approximately the composition Me_2O_3. Presumably at lower potentials, where corrosion again becomes appreciable, the oxides are partly reduced before being dissolved. The fall of corrosion at the lowest potentials represents the conventional anodic polarization curve for the alloy.

These assumptions explain many well-known features of the behaviour of stainless steels, such as the inhibition of corrosion in sulphuric acid by copper or other weakly oxidizing ions which poise the potential within the safe intermediate range. Curves such as Fig. 1 can furthermore give guidance in the development of new alloys, since they can show the effect of each addition element on various portions of the curve and thus explain apparently contradictory results obtained by normal methods. In addition, it is sometimes possible to predict the suitability of any given alloy for a particular application by measurements of redox potentials and by the study of the characteristic curves for the various alloys.

Knowing the behaviour of the steel at the various potentials, potential measurements in a chemical plant can indicate whether corrosion is likely to occur, and therefore can form a valuable means of monitoring plant.

An interesting additional finding is that, even when passivity has fully broken down, it can be re-established by suitable anodic polarization. Furthermore, the passivity of an ordinary 18/8 chromium–nickel steel can be maintained even in boiling 50 per cent sulphuric acid (which normally would cause exceedingly rapid corrosion) by passage of a minute current. This method of protection has recently been demonstrated in a small demonstration pilot plant made from tubes, tube joints, welds and a pump[3]. It seems, therefore, that the formation of new oxide by the reaction of the metal with the solution is possible even though the oxide is only a metastable phase. Oxygen does not seem to be necessary, since protection is possible at potentials not high enough for its electrolytic formation and in solutions de-aerated by constant boiling.

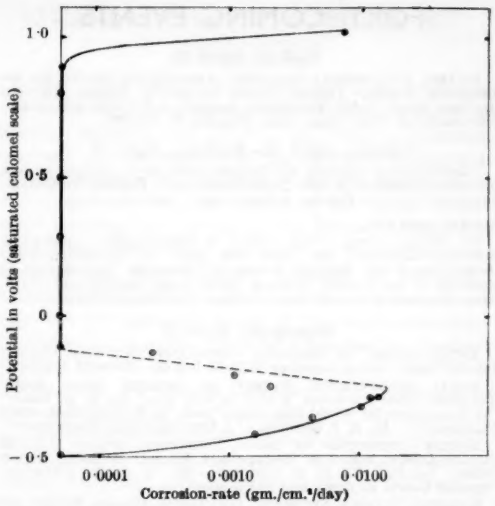

Fig. 1. Effect of potential on the rate of corrosion of an 18/8 chromium–nickel steel by 20 per cent sulphuric acid at 25° C. Weight losses less than 0·00005 gm./cm.²/day plotted adjacent to the vertical axis

Some features of the work will be described in more detail elsewhere; but it may be of interest to note that in a two-phase alloy each phase has a characteristic curve, and it is therefore often possible to find some potential at which only one phase is corroded at an appreciable rate. This leads in the first instance to differential etching and eventually to 'selective' attack, which causes the disintegration of the alloy following the corrosion of one of the phases.

While this is a complicated way of etching alloys, it may serve to explain the action of various conventional etching reagents (which incidentally often contain oxidizing or reducing agents) and may also be useful when controlled means of etching are desirable. Such a case arises when the composition of one phase has to be determined by chemical means.

Other common types of corrosion, such as intercrystalline corrosion and pitting, both of which occur on the portion of the curve which has a negative slope (Fig. 1), can be easily reproduced in these experiments at constant potentials; but the work is still at a very early stage, and these matters have not yet been studied in detail.

C. EDELEANU

The Brown–Firth Research Laboratories,
Princess Street,
Sheffield 4. Feb. 11.

[1] Pourbaix, M. J. N., "Thermodynamics of Dilute Aqueous Solutions" (Edward Arnold and Co., London, 1949).
[2] Roberts, M. H., *J. Sci. Instr.* (in the press).
[3] Corrosion Group Exhibition, Soc. Chem. Indust. (London, 1954).

FORTHCOMING EVENTS

Tuesday, April 20

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, South Kensington, London, S.W.7), at 2.30 p.m.—Discussion on "The Large Scale Clearing of Forests".

Tuesday, April 20—Saturday, April 24

International Council for Electrodeposition, c/o the Institute of Metal Finishing (in the Crown Room suite, Holborn Restaurant, London, W.C.1).—Fourth International Conference.

Tuesday, April 20

Dr. William Blum: "The Future of Electroplating" (Hothersall Memorial Lecture). (Dr. Blum will speak on "Electrodeposition Researches of the National Bureau of Standards, Washington" at meetings of the Scottish, Midland, North-West, Sheffield and North-East Branches of the Institute of Metal Finishing, during May 3–7.)

Wednesday, April 21

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Scientific Papers.

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. J. R. Baker: "A New Lamp for Visual Microscopy" and "A Redesigned Rousselet Compressor"; Dr. R. J. Goldacre: "A Simplified Micro-Manipulator".

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. B. R. A. Bettridge: "Crystal Valves in Radio and Electronics".

Overseas Science Students Association (at the Society for Visiting Scientists, Ltd., 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Mr. Walter Adams, C.M.G., O.B.E.: "University Education in the Colonies".

Wednesday, April 21—Friday, April 23

Oil and Colour Chemists' Association (at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1)—Sixth Technical Trade Exhibition.

Thursday, April 22

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. E. Sinclair: "The Production of Asbestos in South Africa"; Mr. A. H. Debnam: "Geochemical Prospecting at Mt. Isa, Queensland".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. L. S. Bosanquet: "Convergence and Summability Factors".

Friday, April 23

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 4.15 p.m.—Mr. Frederick S. Mallette: "A New Frontier: Air-pollution Control" (James Clayton Paper).

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. E. W. Barlow and Commander C. E. N. Frankcom, R.N.R.: "Surface Currents and their Effects on Navigation".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "A Method for the Plotting of Magnetic Fields due to Currents".

Saturday, April 24

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Ove Arbo Hoeg: "Spitzbergen: Its Present and Past Vegetation".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with a degree or recognized diploma in mining) in the Department of Mining and Geology—The Principal, Wigan and District Mining and Technical College, Wigan (April 24).

University Demonstrator in Agriculture (Animal Nutrition)—The Secretary, School of Agriculture, Downing Street, Cambridge (April 28).

Assistant Lecturer (Grade B) in Zoology, to teach to degree standard—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (April 30).

Lecturer, Grade II (preferably with experience in theoretical work in solid state physics) in the Department of Physical Metallurgy—The Registrar, The University, Edgbaston, Birmingham (April 30).

Lecturer in Geography—The Registrar, King's College, Newcastle-upon-Tyne (May 1).

Scientific Officer (with first- or second-class honours degree in mathematics or equivalent qualification, with an interest, and preferably with experience in operational research methods) in the Department of Scientific and Industrial Research, Building Operational Research Unit of the Building Research Station, London, W.1, for mathematical and statistical studies of the operations, processes and productivity of the building industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.91/54A (May 1).

Assistant Lecturer (with special qualifications in physical geography) in Geography—The Secretary of the Trustees, Magee University College, Londonderry, N. Ireland (May 8).

Assistant Lecturers (2) (one with special qualifications in horticulture, and the other with special interests in biochemistry) in Botany—The Registrar, The University, Manchester 13 (May 8).

Demonstrator (honours graduate, with previous experience of demonstrating to B.Sc. standard) in the Department of Physics—The Registrar, King's College, Strand, London, W.C.2 (May 8).

Readership in Experimental Physics, tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 10).

Chair of Philosophy—The Registrar, University College of North Staffordshire, Keele, Staffordshire (May 15).

Lecturer (with special qualifications in physical and/or inorganic chemistry) in Chemistry at University College, Dundee—The Secretary, The University, College Gate, St. Andrews (May 15).

Professor of Zoology at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 15).

Research Officer (with university honours degree, with major study in fuel technology, physics or mathematics, and preferably with subsequent experience in fuel technology) in the Commonwealth Scientific and Industrial Research Organization Coal Research Station, North Ryde, New South Wales, to investigate the strength and mechanism of breakage of coal and the industrial significance of these phenomena—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/115 (May 15).

Senior Lecturer (with experience in teaching human and mammalian physiology, including the management of practical classes) in Physiology, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, May 21).

Research Assistant in Mathematical Statistics, and a Research Assistant in Numerical Analysis, in the Department of Applied Mathematics—The Registrar, The University, Liverpool (June 1).

Engineers and Physicists, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree or equivalent high professional attainments) at Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52/A.

Lecturer in Aeronautics to specialize in the teaching of undergraduate and postgraduate students in high-speed flow problems—The Secretary and Registrar, The University, Southampton.

Mathematician (with an interest in numerical techniques) to work on analogue and digital electronic computing techniques and their application to physical and engineering problems—The Personnel Officer, Associated Electrical Industries, Ltd., Research Laboratory, Aldermaston Court, Aldermaston, Berkshire.

Physicist (with an honours degree in physics, and some experience of research in metal physics) to lead a small team in research on metal physics problems of interest to the steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Metal Physics".

Research Assistant (with suitable qualifications in animal nutrition, physiology or genetics, preferably related to pig production) to take charge of the Pig Husbandry Research Section—The Secretary, Wye College, near Ashford, Kent.

Research Student (preferably with some experience in aeronautics) in the Department of Aeronautical Engineering, to carry out research on turbulence, noise and high-speed flow problems—The Professor of Aeronautical Engineering, The University, Southampton.

Scientific Officer (with a first- or second-class honours degree in physics or equivalent qualification, and preferably with some years experience in spectroscopic research work or metallurgical analysis) at the Atomic Weapons Research Establishment, Aldermaston, for qualitative and quantitative spectrographic analysis of inorganic substances—The Administrative Officer, Recruitment, A.W.R.E., Aldermaston, Berkshire, quoting 69/WGE/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Metropolitan Life Insurance Company. **Statistical Bulletin**, Vol. 34, No. 12: Large Population Gain in 1953. Pp. 12. (New York: Metropolitan Life Insurance Company, 1953.) [22

Veterinaria Italiana: Rivista di Igiene Profilassi e Terapia. No. 1, Gennaio, 1954. Pp. 104. (Teramo: Instituto Zooprofilattico Sperimentale, 1954.) [22

Brasil: Estado de Minas Gerais. Secretaria da Agricultura, Industria, Commércio e Trabalho. Instituto Agronomico. Circular No. 4: Melhoramento do Mamão (*Carica papaya*, L.). By D. C. Giacometti and L. B. Mundim. Pp. 32. Circular No. 5: Formacão do Pomar Citrico. (Laranjas, limões, tangerinas, limas, "grapefruits" etc.) By D. C. Giacometti. Pp. 16. X. Reuniao dos Tecnicos em Experimentacao, Realizada de le a 19 de Julho de 1953, sob o Patrocinio da Sociedade Mineira dos Engenheiros Agronomos. (III. Semana dos Engenheiros Agronomos.) Ano X—No. 6. Pp. 61. (Bello Horizonte: Instituto Agronomico, 1953.) [22

U.S. Department of Agriculture. Farmers' Bulletin No. 1260: Stored Grain Pests. Pp. ii+46. 20 cents. Home and Garden Bulletin No. 28: Ants in the Home and Garden—How to Control Them. Pp. 8. 5 cents. Circular No. 923: Parasites of the Hessian Fly in the North Central States. By C. C. Hill. Pp. 16. 5 cents. (Washington, D.C.: Government Printing Office, 1953.) [32